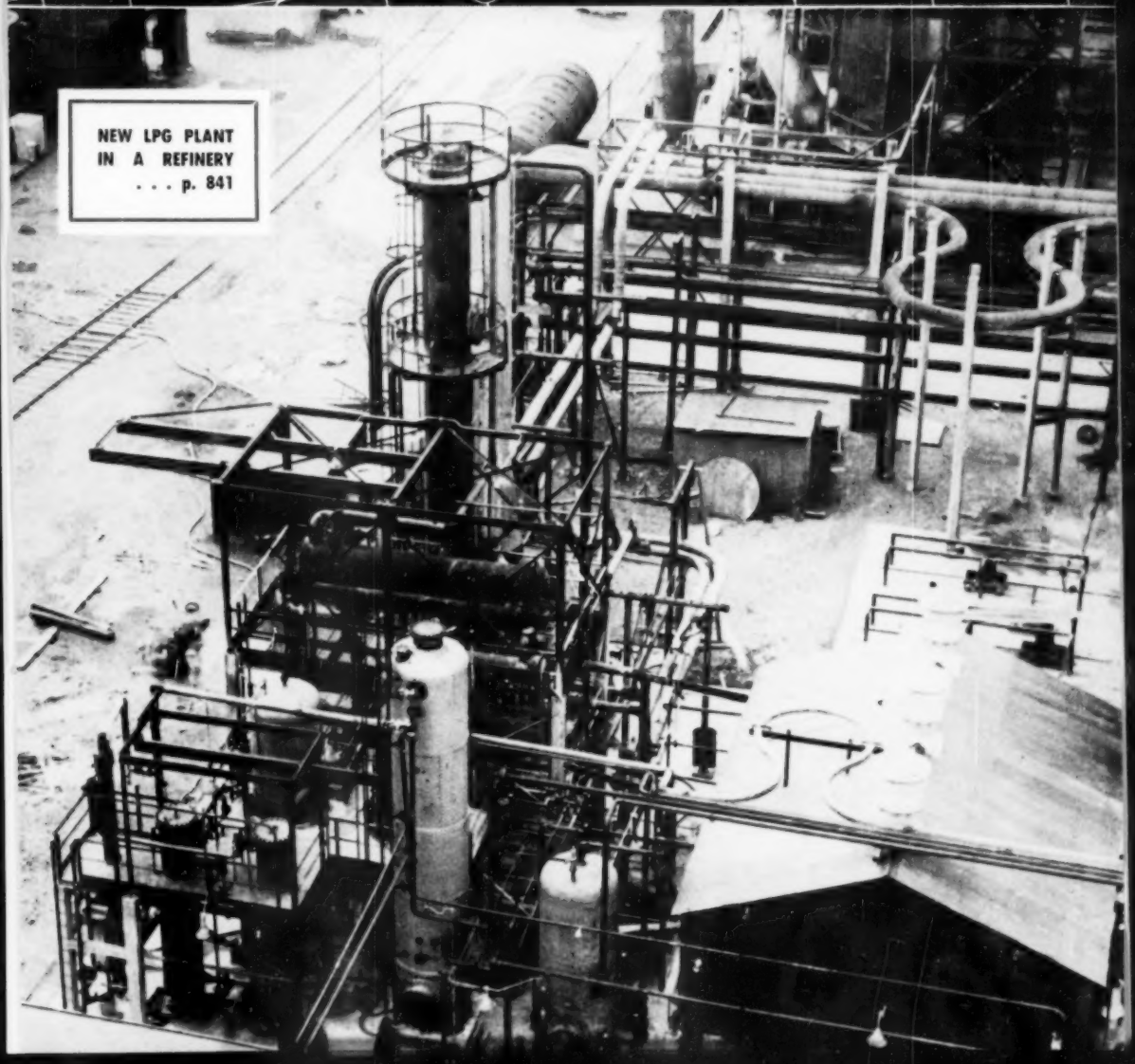
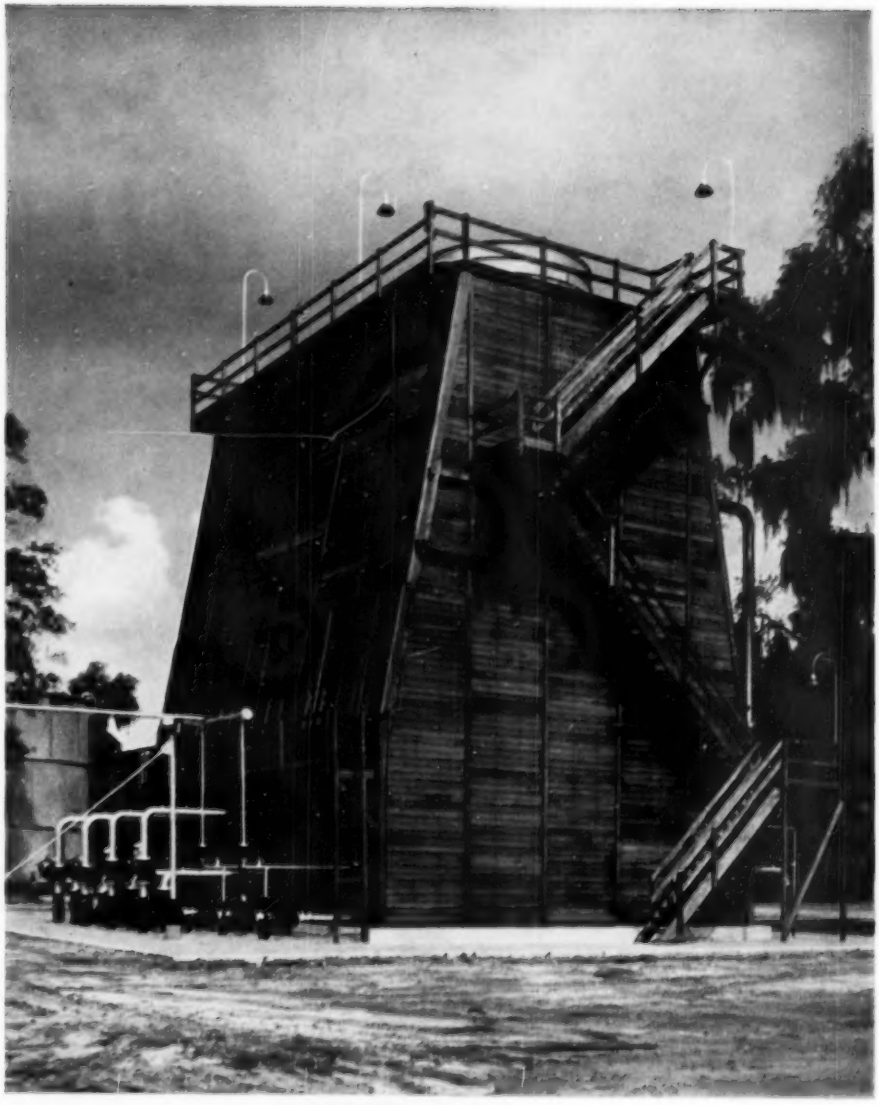
AUGUST, 1950
VOL. 5, NO. 8

PETROLEUM PROCESSING



NEW LPG PLANT IN A REFINERY
. . . p. 841



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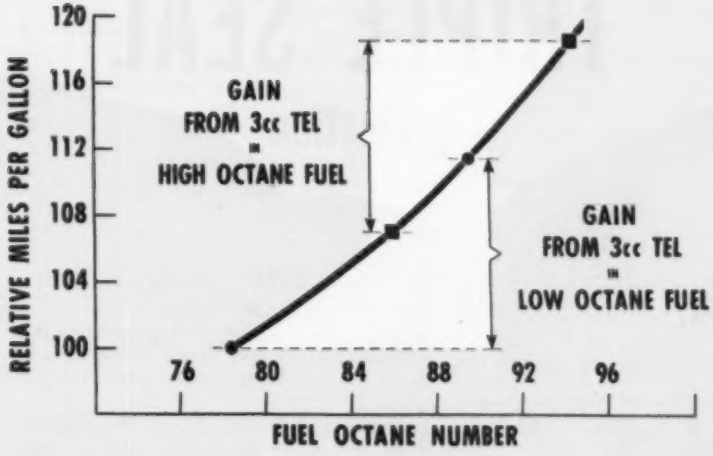


When measured by increased miles per gallon, tetraethyllead is just as effective blended in today's high octane base gasolines as in the lower octane gasolines of the past.

THERE has been a remarkable increase in the antiknock quality of base gasolines since "Ethyl" antiknock compound was first marketed in 1923. Despite this increase in the octane number of base gasolines, tetraethyllead is as effective as ever from the standpoint of the extra miles-per-gallon it can contribute.

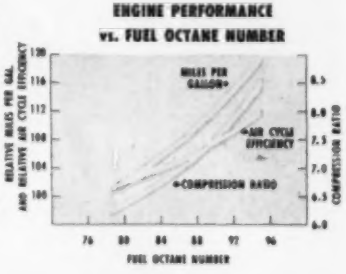
The charts show data obtained in tests made at 6.1 and 8.5 compression ratios on an automobile equipped with an overhead valve engine, and with axle ratios selected to provide equal acceleration ability at low speed. Values of average fuel economy over the speed range between these compression ratios were computed by methods which check with experiment.

The chart below shows that permissible increase in compression ratio per octane unit becomes larger as the octane number of the fuel is raised, and shows that octane numbers at the higher levels are increasingly effective in the improvement of gasoline economy on the road.

From 6.1 to 8.5 compression ratio (corresponding to an increase in octane number from 78.3 to 95) the miles-per-gallon of fuel are boosted by approximately 19%. In contrast, the air cycle efficiency increases only about 11% over the same range of compression ratio.

In the chart above, the gasoline mileage curve of the lower chart is repeated. On the curve, the two circles show the improvement contributed by 3.0 cc tetraethyl lead when added to a base fuel of 78.3 octane number. The two squares show the gain from 3 cc tetraethyllead when added to a base fuel of 86 octane number. *The additional miles-per-gallon* are substantially the same.

Thus, when tetraethyllead is added to commercial fuels, it is just as effective for improving fuel economy on the road at today's high octane levels as at the lower octane levels of the past.



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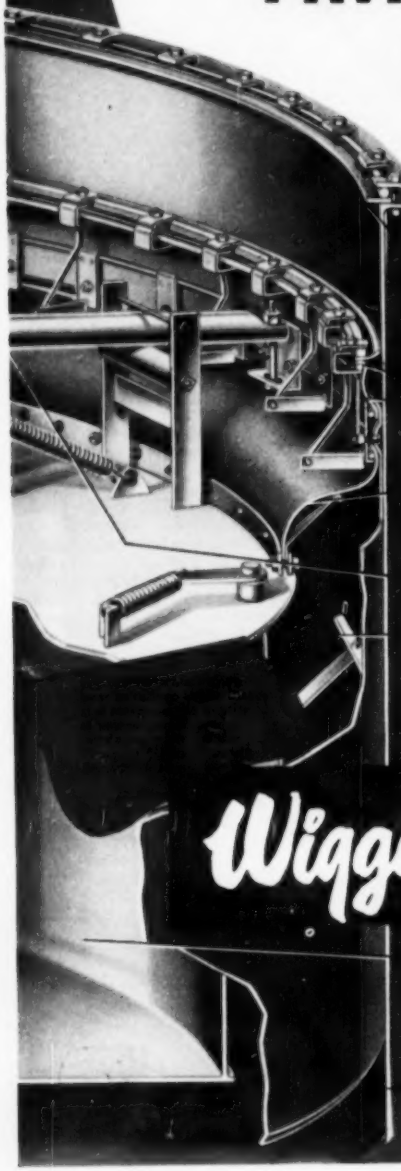

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PLATT'S OILGRAM PRICES
A daily independent oil-price reporting service issued from New York, Cleveland, Houston

New Facilities Boost Ohio's Gasoline Yield

By Harry E. Handy
Superintendent
Robinson, Illinois, Refinery
The Ohio Oil Company

An increase of 7,000 barrels per day in the crude capacity of our principal refinery at Robinson, Illinois, has been effected with the completion of an extensive expansion and improvement program.

Harry E. Handy

Enlargement of our facilities was necessitated by the steadily growing demand for our products. In addition to processing more crude than formerly, the new facilities have enabled us to reduce former fuel oil yields by approximately one-third while substantially increasing the yield of gasoline and middle distillates.

Include Fluid Cat Cracker

The new facilities, process designed by Universal Oil Products Company, include a 27,500 b/sd two-stage crude distillation unit, a 12,400 b/sd UOP fluid catalytic cracking unit, a UOP catalytic-polymerization unit, a gas recovery system and a gasoline treating plant. Auxiliary facilities required as a result of the expansion of processing units included a water-circulating pump house, a cooling tower, a power house extension, 1,250,000 barrels of new tankage, an Ethyl blending plant and an A.P.I. oil separator.

The new processing equipment was installed as an integrated refinery area on a completely new site, thus allowing for economies in operating and maintenance which would not have been possible had the old equipment been combined in a revamp. Furthermore no costly shut down time was involved, as the old facilities could be operated up to the startup of the new plant.

The crude distillation unit includes facilities for atmospheric distillation, vacuum distillation and oxidizing or air blowing of asphalt. The crude oil passes through a desalter before entering the prefractionating column of the atmospheric unit.

Unit Simple in Design

The fluid catalytic cracking unit is of the latest design in which the regenerator is placed below the reactor and operates at approximately 15 psig. This made it possible to reduce the diameter of the regenerator 30% compared to a unit in which regeneration is carried out at approximately atmospheric pressure. It also resulted in elimination of the spent catalyst risers, which was one of the most troublesome lines in the wartime plants from the standpoint of maintenance.

(Advertisement)

The catalyst recovery system consists of three stages of cyclones on the regenerator, making unnecessary the installation of an electrical precipitator which was used on earlier units to recover catalyst fines. The reactor design includes dense phase horizontal grids in addition to the main distribution grid for reducing catalyst recycling in order to prevent excessive cracking and to insure maximum gasoline recovery. Internal and external strippers are provided for two-stage stripping of the spent catalyst. The reactor, external stripper and main fractionating column are lined with 11-13% chrome alloy to protect the equipment against the action of corrosive stocks.

Auxiliary Equipment

Auxiliary equipment for the cat cracker includes a pressured slurry settler, fired charge heater, flue gas steam generator and main fractionator steam generators, steam superheater for high pressure steam generated on the unit, gas engine driven gas compressors, and a condensing turbo blower silencer at the regenerator flue gas exhaust.

Prior to the completion of the new facilities we were operating the old crude unit (Crude Unit No. 1) at a crude rate of 18,000 b/sd on Illinois crude. The virgin gas oil was thermally cracked and the naphtha and heavy straight run grade was reformed in the Holmes-Manley cracking units in order to meet octane specifications. We were also operating a combination cracking coil with a crude capacity of 2,500 b/sd. This unit has facilities for crude distillation, visbreaking reduced crude and thermally cracking the gas oil fraction. The C_3-C_4 fractions from all these various cracking operations were processed in our old UOP catalytic polymerization plant for the production of polymer gasoline.

Crude Rate Up 7,000 b/sd

Since the installation of the new crude unit we have discontinued the operation of the old crude unit and also the combination cracking coil. The new unit (Crude Unit No. 2) handles all the crude we require, and is now operating at a crude rate of 28,000 b/sd, or approximately 7,000 barrels greater than was previously obtained by the operation of both the old crude unit and the combination unit.

The virgin gas oil from the crude unit is now charged to the fluid catalytic cracking unit and the mixed catalytic cycle stock is thermally cracked in the Holmes-Manley units. The naphtha reforming operation has been discontinued since the higher octane rating of the catalytically cracked gasoline for the present permits us to meet our octane specifications without the reforming operation and its accompanying reduction in gasoline yield.

The old UOP poly plant has also been discontinued since it is too small for the charge we now have and all the C_3-C_4 fractions from the cracking operations are processed in the new poly plant.

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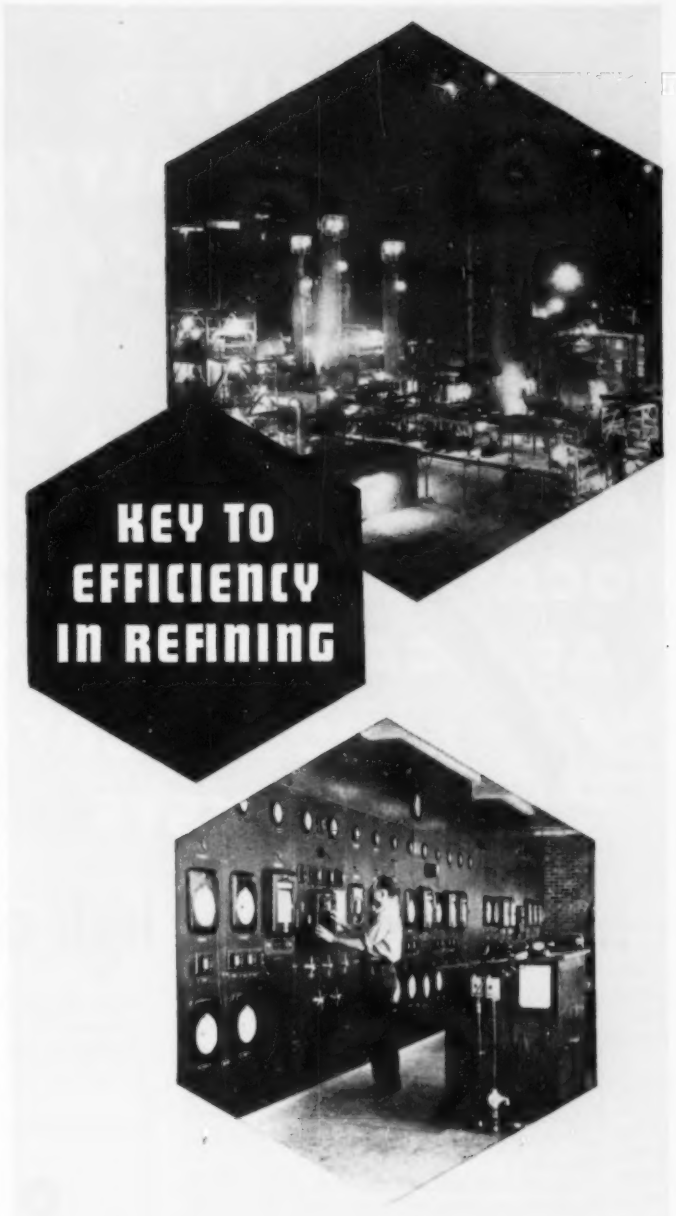

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[*To obtain more data on advertised products see page 882*]

...Background for high octane fuels

Today, thanks to the fluid cracking techniques used in modern refining operations, it is possible to produce high octane fuels to match the requirements of engines of high compression ratio. Contributing vitally to this progress has been Cyanamid's development of AEROCAT* Ground and Microspheroidal Synthetic Fluid Cracking Catalysts.

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WHEN PERFORMANCE COUNTS . . . CALL ON CYANAMID

What's Happening!

Important Current News Summarized for Refiners

EXPANSION

Socony-Vacuum Oil Co., Inc., will build a new TCC Unit at the East Chicago refinery, making a total of eight such units under construction or to be completed during 1950. Construction contract has been let to C. F. Braun & Co. Unit is of "gas lift" type, and replaces an existing fixed bed Houdry unit. It's design capacity is 15,000 b/d.

Standard Oil Co. of Calif. has awarded contract to M. W. Kellogg Co. for construction of a 55,000 b/d vacuum flashing unit at its Richmond, Calif., refinery. Unit is said to be largest in world, with about 15% more capacity than any vacuum unit now in operation. California Standard currently is converting its 32,500 b/d Thermofor catalytic cracking unit at Richmond to a Houdriflow unit. Both units are scheduled for completion next May.

Mathieson Hydrocarbon Chemical Corp. has awarded contract for a new $17,000,000 petrochemical plant at Brandenburg, Ky., to E. B. Badger & Sons Co., with Stone & Webster Engrg. Corp. collaborating on some phases. Plant will produce ethylene glycol and other chemicals from ethane via chlorination route.

Union Oil Co. of Calif. started construction Aug. 1 on a million-dollar asphalt plant at Edmonds, Wash. Crude will be shipped by tanker from California to the plant, which will have an annual capacity of 65,000 tons of paving asphalts, road oil and cutbacks. Completion is scheduled for June, 1951.

Premier Petroleum Co. has announced plans to install a 1,500 b/d Platforming unit at its Ft. Worth, Texas, refinery.

• • •

TRANSITION

Coastal Refineries, Inc., has been acquired by Taylor Refining Co. of Taylor, Texas. Assets acquired include 6,000 b/d refinery at Port Isabel, Texas, and cycling plant near McAllen, Texas. Taylor Refining said there will be no change in management or in operating personnel as result of corporate change.

Wood River Oil & Refining Co. has sold its 35,000 b/d refinery at Hartford, Ill., to Sinclair Refining Co. Refinery was built in 1940 and recently modernized with a Fluid catalytic cracking unit, cycloversion unit, polymerization unit and additional vacuum distillation equipment. Sale was announced July 3.

Cities Service Oil Co.'s 3,000 b/d refinery at Titusville, Pa., has been sold to Quaker State Oil Refining Co. Titusville plant has conventional lube oil manufacturing facilities. According to Cities Service, sale follows logically the recent completion of the new Cit-Con lubricating oil refinery at Lake Charles, La., which supplies Cities Service with 4,000 b/d of solvent refined lubes. Titusville plant has conventional lube manufacturing facilities.

Husky Refining Co. has been reorganized as Husky Oil Co., a Delaware corporation, with no change in ownership. Husky operates a 4,500 b/d skimming and asphalt refinery at Cody, Wyo., and has another 2,500 b/d skimming plant at Lovell, Wyo., now shut-down.

Waverly Oil Works Co. has sold its 2,500 b/d refinery at Pittsburgh, Pa., to Pennzoil Co. for $425,000. Pennzoil does not plan to operate the refinery, unless world situation calls for continued operation, but will use the site as bulk plant and terminal.

• • •

MARKETS, PRICES

July was one of the most active months in the history of oil markets. Active pricewise, that is, for prices rose over a broad front, and almost daily. Actual trading in the open market was restricted, however, by lack of general offerings. There were few, if any, anxious sellers of any product, although the anxious buyers were many.

Demand for virtually the entire list of refined products outpaced the availability of open market material to the point where, as during the fuel shortage in the winter of 1947-48, "premiums" (above low quoted prices) were being offered by many buyers in an effort to pry loose offerings. Most pointed in this respect were lubricating oils.

The rise in lube oils was sharp during the past month. Pennsylvania 25 pour test bright stock jumped from 19.5c on June 30 to 23c a gal. at the end of July. Some refiners were selling at 23c to their regular jobber and compounder customers; large company buyers were bidding and paying 25c. As of now, the rise in Pennsylvania bright since the first of the

Information on these pages is obtained through the nation-wide news coverage service of PLATT'S OILGRAM NEWS

year totals 6 to 8c a gal., from 17c to 23-25c. Mid-Continent solvent bright rose 2c to 24c a gal. the past month, and currently is up 5c a gal. from the low quoted price of 19c on Jan. 1.

Lubes were not the only items to enhance in value for the refiner. Gasoline (regular grade) in primary markets advanced 0.125 to 0.25c, to 10.25c, Group 3, and 11c for cargo lots at the Gulf. Heavy fuel was up 10c at the Gulf, to $1.75 per bbl. for Bunker "C". In the Mid-Continent, No. 6 oil dropped 5c to $1.60, then rallied back to $1.65 before the end of July. Natural gasoline advanced 0.5c over the month, to 5.875c a gal. Group 3, 5.375c Breckenridge, for Grade 26-70.

Raw materials costs were unchanged for most refiners, changes the past month being in those crudes which, over a year ago, had dropped sharply from their postwar peaks. The second increase in less than a month, 10c per bbl., was posted by Standard of California for heavy crudes on the West Coast. Pennsylvania crudes got their third 1950 increase, this time 14c per bbl., when South Penn Oil Co. posted $3.89 for Bradford-Allegany (top Penna. grade). Increase in Pennsylvania crude in 1950 to date totals 35c per bbl.

• • •

NATURAL GASOLINE

Sunray Oil Corp. will operate the largest gas conservation project yet announced for the prolific Scurry County, Texas, area. The gasoline plant—a cooperative project—will process approximately 67,000 Mcfd of gas, and produce in excess of 450,000 gal. per day of liquid products. Work on project is expected to start by about the middle of October, with operation scheduled for next Spring.

• • •

SYNTHETIC RUBBER

Three synthetic rubber plants are being put back into service—all government-owned: GR-S copolymer plant at Port Neches, Texas, with annual capacity of 75,000 tons; butadiene plant at Houston, with annual capacity of 50,000 tons; Butyl rubber plant at Baton Rouge with capacity of 13,000 tons.

Reactivated plants will boost synthetic rubber production capacity by about 88,000 tons annually, raising total annual capacity to about 500,000 tons of GR-S and 75,000 tons of Butyl.

Sinclair Rubber, Inc., will operate the Houston butadiene plant; Esso Standard the Baton Rouge Butyl facilities; and U. S. Rubber Co. the Port Neches GR-S plant. The first two facilities were previously operated by the same firms; the Port Neches plant, however, was run during the war by Firestone Tire & Rubber Co., and maintained in standby condition by B. F. Goodrich Co.

• • •

Phillips Chemical Co. will replace U. S. Rubber Co. as operator of the government-owned GR-S synthetic rubber plant at Borger, Texas. Phillips already operates a butadiene plant in that area.

• • •

SYNTHETIC FUELS

Legislation to extend government's synthetic liquid fuels research program another three years has been approved by House, and passed to Senate. Bill (H. R. 8975) was introduced late in June, given committee approval July 13, and passed by House without objection and with less than 10 minutes of debate July 20. Measure authorizes expenditures of an additional $27,600,000, and extends the program until April 5, 1955.

Kansas State Geological Survey is undertaking a sampling and detailed investigation of oil shales in southeastern Kansas. Purpose is to determine character and size of shale deposits in the state that may be utilized in the future.

Bureau of Mines has undertaken an investigation of most desirable process for producing chemicals in conjunction with synthetic fuels. One objective of the study is to find new sources of supply for those aromatics (such as benzene and phenol) now in short supply or expected to be in time of emergency.

• • •

COMPLETIONS

Stancal Asphalt & Bitumuls Co., subsidiary of California Standard, last month opened its new $500,000 asphalt refinery at Point Wells, Wash.—the first coastal Washington asphalt works. The refinery will produce 150,000 tons of paving asphalt annually.

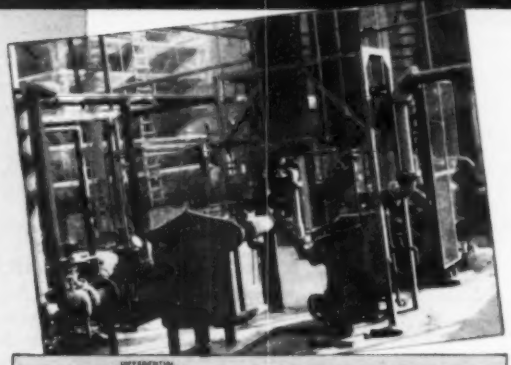
Standard Oil Co. (Ohio) put its new $13 million solvent lube plant at Lima, Ohio, on stream in July. Plant has capacity of 75,000 gal. of finished lubes per day.

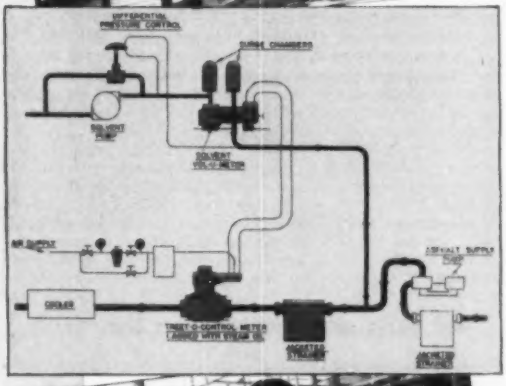
• • •

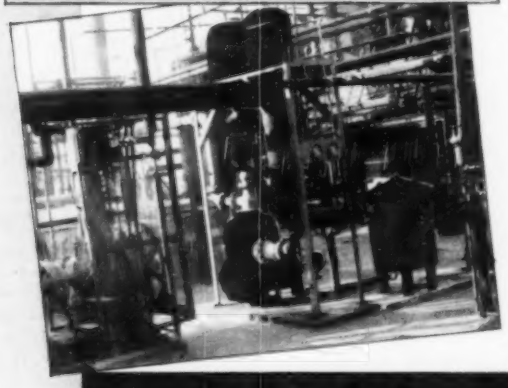
MISCELLANY

Procon, Inc. is a new firm organized to handle the construction of refinery specialty installations, with headquarters in Chicago. A subsidiary of Universal Oil Products Co., Procon will handle particularly units for Universal's new Platforming process. President of the new firm is J. C. Raaen; vice president and general manager is C. B. Whyte.

Clean Up Your Asphalt Blending Operation







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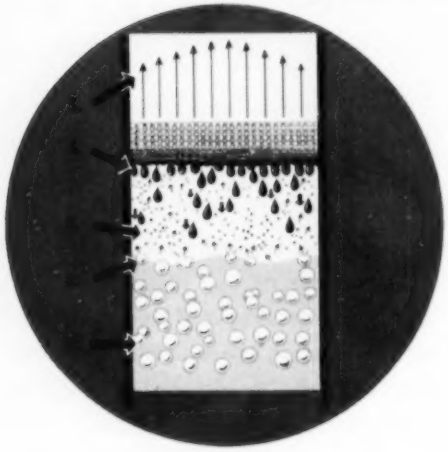

HOW A METEX MIST ELIMINATOR WORKS

Bubbles of gas, passing through a liquid (1), burst on emerging (2) and form a fine spray which rises entrained in the gas flow (3). As this mixture passes through the Mist Eliminator, the entrained liquid is "wiped out" and retained by the extensive wire area until it forms drops sufficiently large to fall back through the rising flow (4). The gas continues on (5), entirely freed from entrainment.

In Metex Mist Eliminators is found the practical application of impingement filtration to the purification problems involved in liquid-gas separation processes. (See illustration) Baffles, centrifugal chambers or additional head room above the disengaging surface are not required, nor is it necessary to slow down operations to secure separation of the entrained liquids.

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A Metex Mist Eliminator is a pad consisting of multiple layers of wire mesh, which is *knitted*—not woven—from corrosion resistant metal. Each layer is diagonally crimped, with crimps running at right angles in successive layers of mesh.

To insure accurate fitting and ease in handling and installation, each Mist Eliminator is assembled, prior to shipment, from long narrow strips of the desired thickness. These are cut to fit the shape and dimensions of the equipment in which the pad is to be installed. Sections are readily passed through man holes and assembled within the equipment at the desired location, and across the line of flow.

WHY METEX MIST ELIMINATORS ARE EFFECTIVE

1. Their unusually high free volume (often 98%) imposes minimum resistance to flow of gases.
2. The multiplicity of wires makes "straight line" passage of gases impossible.
3. Entrained liquid is "wiped out" on these wires, to coalesce and fall back through rising vapors.
4. Maximum resistance to corrosion is obtained by selection of the metal or alloy used for wires.
5. Easily installed or replaced in new or existing equipment.

Our engineers will be glad to consult with you on your entrainment problems. Ask for free copy of our brochure, "Metex Mist Eliminators." It costs you nothing and can save you much.

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Tomorrow

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Brief Reviews of Current Technological and Economic Developments, Reported in the Light of Their Possible Effect on Future Petroleum Processing Operations

Korean Crisis Will Boost 1950 Petrochemicals Output

DESPITE declines in the production of several petroleum chemicals which were in large demand during World War II, total production of "crude products" from petroleum and natural gas for chemical conversion rose to approximately 5,000,000,000 lbs. in 1949 as compared with 3,900,000,000 in 1948. Output of both aromatic and aliphatic hydrocarbons increased; that for aromatics and naphthenes totaled 1,005,493,000 lbs., an increase from 892,000,000 lbs. in 1948 (largely because of greater production of miscellaneous distillates, solvents, phenolates, and phenols). Petroleum-derived toluene and xylene were produced in smaller quantities than in 1948. Preliminary 1949 Tariff Commission statistics are shown in Table I.

Even before the Korean conflict, predictions indicated that 1949 output would be exceeded in 1950; one anonymous source went so far as to prophesy a total of 12,000,000,000 lbs, more than twice the 1949 figure. What the effect of the present preparedness program will be is not completely predictable, but its influence on output (if not profits) seems definitely "bullish." In fact, as regards the production of chemicals as a whole, combined demands for peacetime and wartime uses will probably exceed the production capacities in many chemical fields.

Moreover, according to Ronald E. Meyer of the Warren Petroleum Corp.,(1) "the time has arrived for the petroleum industry to decide whether or not to counteract its declining profits with diversification to a greater extent into the chemical field." High profits obtained in that field by chemical companies are serving as a spur to this decision, along with such factors as the present market price for ethane, most of which "is now being sold as a constituent of residue gas for about 6c per mcf, or 0.25c/gal., even though it is potentially worth much more as a raw material for chemical manufacture."

The Korean situation and its ramifications are already being felt in a "new" petrochemical field—that of benzene synthesis. Even before the Government decided to open standby synthetic rubber plants (which consume styrene, a benzene derivative), the anticipated 1950 supply of benzene was already thought to be 15,000,000 gals. short of this country's demand. "Civilian" uses of benzene—in polystyrene plastics, phenolic resins, etc.—will undoubtedly suffer, and the overwhelming demand will undoubtedly cause other petroleum companies to scan their refining processes and products for ways of producing benzene; some may join Pan American Refining Corp. in producing it by hydroforming, since the price obtainable should yield profits. However, the semi-wartime demand for aromatic aviation gasolines may very well interfere with such plans.

In the last few years, the construction of plants to produce chemicals from petroleum has been at record levels. While the present conflict will undoubtedly have its effect on the availability and costs of materials of construction, the urgent need for increased production of certain petrochemicals indicates the probability that more and more new plants will be constructed.

Growing Plastics Field Calls for Petrochemicals

PLASTICS have long been of interest to the petroleum industry, both as substances which might be synthesized from petroleum raw materials and as products which might be used in plant construction and exploration. In recent years, almost all of the "new" plastics and synthetic fibers have been synthesized from petroleum chemicals.

The public usually envisions plastics as molded or extruded (solid) articles, and production of these will probably continue to dominate the plastics industry, but increased attention is being given to textiles, surface coatings, and insulation materials. As P. O. Powers of the Battelle Memorial Institute recently told the American Institute of Chemists, however,(2) "it is hard to visualize, at the present time, anything fundamentally different from the existing plastic materials," although "the improvement and modification of existing types will continue and, in many cases, the improvement of existing types of plastic materials will result in as great an expansion as the intro-

TABLE I—1949 U. S. Production and Sales of Crude Products from Petroleum and Natural Gas for Chemical Conversion[1]

	Production 1,000 lbs.	Sales 1,000 lbs.	Sales $1,000
Aromatics and Naphthenes, total	1,005,493	777,592	28,511
Naphthenic acid[2]	22,981	8,203	819
Toluene, all grades[3]	348,823	288,796	8,989
Xylene, all grades[4]	356,122	230,681	6,588
All other aromatics[5]	277,567	249,912	12,115
Aliphatic Hydrocarbons, total	3,984,413	2,295,605	83,068
C_2 hydrocarbons:			
Ethylene[6]	1,129,337	130,234	7,425
C_3 hydrocarbons	1,087,333	859,102	9,737
Propane	800,205	...	...
Propylene and propane-propylene mixture	287,128	...	...
C_4 hydrocarbons, total	1,459,240	1,024,863	59,652
1,3-Butadiene	493,844	476,537	42,007
1-Butene and 2-butene fraction[7]	613,400	399,301	12,953
All other	351,996	149,025	4,692
All other aliphatic hydrocarbons, total	308,503	281,406	6,254
Di-isobutylene	10,676	...	...
All other[8]	297,827	281,406	6,254
Grand total	4,989,906	3,073,197	111,579

(1) U. S. Tariff Commission preliminary 1949 release, 5-50.
(2) Includes data for crude sodium naphthenate.
(3) Includes data on a 90% toluene basis for crude toluene concentrate used in aviation fuel. U. S. toluene production from all sources totaled 586,530,400 lbs. (81,012,500 gals.).
(4) U. S. production from all sources totaled 413,951,200 lbs. (57,413,500 gals.).
(5) Includes alkyl aromatics, aromatic distillates and solvents, crude sodium carbolate and phenolates, petroleum phenols, and crude (petroleum-derived) creysilic acid. Production of the latter from all sources totaled 23,008,700 lbs.
(6) Data more complete than in previous years. Production of ethylene from ethyl alcohol totaled 144,700 lbs.
(7) Butene content of crude refinery gases used in the manufacture of butadiene.
(8) Includes n-butane, isobutane, butenes, butylenes, isobutylene, and butadiene-butylene mixture.
(9) Includes ethane, pentanes and pentenes, isoprene, hexanes, heptanes, nonene, polybutene, tetrapropylene, and hydrocarbon mixtures, polymers, and solvents.

duction of an entirely different chemical type of material."

As regards future increases in production, Powers points out that a continuation of the trend of recent years would yield a production level 1,000 times greater than the present in 50 years. However, he does not anticipate any such rate of increase over such a long period, although he believes that the rate of growth over the next few years may be even greater than in the immediate past. "Certainly, the volume of production will be increased at least ten times in the next half century, and there are possibilities that a hundredfold increase is not impossible.

"The supply of raw materials, however, may well be one of the limiting factors in the growth curve. . . . The growth in the immediate future will have to come largely from petrochemicals. It is, however, apparent that the demands of the plastics industry in this field will increase greatly, and unless the rate of production is tremendously increased, adequate supplies will not be available, since the projected future figure for the year 2000 is greatly in excess of the world production of crude oil in 1949.

"These considerations indicate the possibility that plastic materials from natural products such as cellulose and rubber may become increasingly important in the plastics field," although "the trend, if any, has been in the other direction. The materials from these natural products have proved to be rather more expensive than the entirely synthetic plastic materials which have supplanted them in a large number of fields."

Incidentally, it has been estimated[3] that "there are 3,500 companies in the U. S. concerned with the production of plastic materials and the manufacture of plastic articles from them. These firms employ in the neighborhood of 100,000 people, and plastic products made this year probably will exceed $1,000,000,000 in value."

Privately Owned Atomic Energy Plants Proposed

ALMOST lost in the debate over the imminence of an atomic war has been a proposal made in June, just before the Korean conflict, by Charles A. Thomas, executive vice-president of the Monsanto Chemical Co., who suggested that private industry build with its own funds plants to produce atomic (nuclear) energy, in partnership with the Government which would loan or lease the uranium and would purchase the plutonium and isotopes and other fissionable by-products produced.

According to Thomas,[4] "the first step might be a $35,000,000, 75,000-kw. power plant in Idaho, built by private industry. The plant would furnish power to produce phosphorus for fertilizer, while still supplying the Government with plutonium." Thomas also proposed that uranium fuels should be leased to petroleum companies "for cracking petroleum." Transfer of uranium and plutonium, etc., would be under guard. "The Government would pay a fee to industry for converting a portion of the uranium into plutonium. This fee would offset the increased power cost."

High Fuel Needs of Turbines May Be Offset by Low Costs

EACH time a "new" source of energy or a new prime mover comes along, speculation becomes rife as to its use in automobiles. This has been true, during the past six years particularly, in the case of the gas turbine, with optimism repeatedly failing to heed more factual pronouncements of engineers.

Typical of the latter is the recent statement by S. H. Hage, chief of Boeing's Propulsion Development Division, that he does not see near-future use for gas turbines in "present-design" cars. According to one report,[5] however, Hage did "predict a use in buses and trucks, of present design, as a 'booster power plant for short periods.'" He believes that the high fuel consumption of turbines will be offset by ultimate low maintenance costs and low first costs, if and when mass production is achieved. "In five to ten years, he predicted, it (the gas turbine) will provide 'good competition' with gasoline and Diesel power plants." Tests conducted by Boeing have shown that gas turbines can burn many fuels, and Hage states that the engine "has good possibilities to burn fuel oil of a less-refined nature at a third to half cheaper" than ordinary motor fuels.

In a recent *Chemical Engineering* survey on gas turbines[6] by L. N. Rowley, executive editor of *Power Magazine*, it was stated that "the economic position of the gas turbine will grow clearer as experience with . . . commercial units piles up, and as manufacturers secure enough business to establish costs on a production basis. At present, a gas turbine plant of high efficiency looks somewhat more expensive than a Diesel or gas engine plant, and is less efficient. It will, however, burn cheaper fuel (Bunker C type). The margin is close enough to make investigation of such a plant worthwhile. The simple gas turbine has the virtue of low first cost, ease of installation, and lack of need for cooling water. These characteristics make it attractive as a peak-load or standby unit, as a plant for remote and water-scarce areas, and as a unit combination with others. . . . For the time being, at least, gas turbines must operate on gaseous or liquid fuels. Research on coal burning is taking a promising turn, however, and it may be possible in the future."

Rowley states that the thermal efficiency of simple gas turbine plants is 17-20%; "adding a regenerator, intercooling, and reheating brings us up to the 28-30% range. This is about as far as American designers seem to consider it advisable. European designers, using intercooling and reheating to a greater extent, in considerably more complex plants, claim efficiencies of 35-37%." One recent low-efficiency gas turbine was installed at an over-all complete cost of about $105 per kw., "well under possible alternatives."

Moreover, much debate continues to rage between advocates of the turbo-jet and turboprop engines for commercial air transport use. The recent SAE meeting[7] "left this impression:

"(1) The Canadians and British are ready to go into production on both turbojets and air frames for jet transports, and their airlines have already ordered small numbers. Chief objection to these units is high fuel consumption;

"(2) American and British engine builders have several turboprops now flying experimentally and more on the way for commercial transport use. Many regard these turboprops as the next logical step in air transport engines because postwar transports now using piston engines can be converted for turboprops. Besides, these turboprops offer considerably better fuel economy than presently available turbojets;

"(3) Both turboprop and turbojet designs will benefit over the next few years from such developments as inlet anti-icing, more efficient compressor types, higher pressure ratios, and higher gas temperatures. Variable-area jet nozzles will increase propulsive efficiency of turbojets, and better propellors will do the same for turboprops; and

"(4) Ultimately, turbojets will power transports for 600 mph. and maybe faster flights over major routes. Turboprops will power transports for 400-500 mph. shorter-haul flights."

References

(1) Ronald E. Meyer, "Petroleum Products vs. Petroleum Chemicals," *Chemical and Engineering News* 28, No. 23, 1906-10 (1950).

(2) P. O. Powers, "The Next Fifty Years in Plastics," Paper presented before the Annual Meeting of the American Institute of Chemists, May 11, 1950.

(3) Anon., "Plastics is Big Business," *Oil, Paint and Drug Reporter* 157, No. 25, 36 (1950).

(4) Anon., *Wall Street Journal*, June 12, 1950, p. 2.

(5) Anon., "Low Cost Offsets Turbine Fuel Needs," *SAE Journal*, 58, No. 5, 83 (1950).

(6) L. N. Rowley, "L. C. Engines and Gas Turbines Raising Fuel Economy," *Chemical Engineering*, 57, No. 5, 126-28 (1950).

(7) Anon., "Aero Meeting Forecasts Turbojets and Turboprops After 1955," *SAE Journal*, 58, No. 5, 68-74 (1950).

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Today's value-wise motorist demands premium performance when he pays premium prices for lubricants. He's likely to ask, "What makes this premium-priced oil worth more?" Your dealers need not hesitate to answer such questions if you employ Monsanto Additives to put premium performance in your oils . . . and tell your dealers about the improvements you've made. For details on Monsanto Additives, mail the coupon. MONSANTO CHEMICAL COMPANY, Organic Chemicals Division, 1746-G South Second Street, St. Louis 4, Missouri.

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Santopoid* 29 — Enables a single gear lubricant to properly lubricate hypoid and other gears under severe operating conditions in high-speed passenger cars, heavy-duty trucks, tractor-trailers and buses.

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Santolubes 205, 206, 360, 374, 321, 322, etc., can be adapted to your base stocks for medium and heavy-duty service.

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Letters . . .

Synthetic Rubber

. . . While I am delighted to find your influential publication actively urging a strengthening of the national position in the production of synthetic rubber [July PP, "New Rubber Program Needed—Now", p. 778], I doubt whether it is possible to do anything along this line under present conditions save to reactivate the existing government-owned plants as quickly as possible.

If this should turn out to be the case, I hope you will not lose your interest in the matter, however, and when conditions improve I hope to find you again campaigning for a sound synthetic rubber industry under private auspices.

FRANK A. HOWARD
New York, N. Y.

● . . . the article appears to be quite factual and well written. There is, however, one point which we feel should be contained in any over-all study of the rubber situation, and that is that there are times when "international security" may be quite as important from the U. S. viewpoint as "national security."

With the present high consumption which we are now experiencing in this country there is from the producers' standpoint a more than satisfactory demand for their product and the price of natural rubber bears this out. If at some time in the future, however, the U.S.A. demand shrinks to a point where the price for rubber brings on poverty and malnutrition in the areas where rubber is produced, thereby making them vulnerable to Communism, *then* we feel that a subsidized synthetic rubber industry should not be used as a price weapon to cut off our Far Eastern allies from this market.

At the present time, of course, both natural rubber and synthetic rubber are short and we are faced with a possible war. Needless to say, under these circumstances we fully support the President's recent decision to reopen several synthetic plants, solely because the needs of national security demand it.

H. C. BUGBEE
Associate Director
Natural Rubber Bureau
Washington, D. C.

● The thing that has bothered me for some time is that it seemed evident that we were growing nearer to a crisis that might effect the supply and consumption of rubber, rather than moving into a more stable international situation. The present shortage in the supply of benzol, which has seriously delayed the in-

[*To obtain more data on advertised products see page* 882]

creased output of the copolymer plants, is only one of the many complications which would be certain to arise as the pressure for military supplies increases.

Also, no matter how smoothly the transition might be accomplished, a change from government operation to private operation would create a period of stagnation which would last for many months, in which time neither the Government nor the prospective purchasers would or perhaps could move to modify or extend the program as it then existed.

For these and other reasons I have felt that this is not a good time to transfer the industry to private hands. The oft repeated assertion that research and development is suffering because of the delay does not have any factual background that I can discern.

RAY P. DINSMORE
Vice President
Goodyear Tire & Rubber Co.
Akron, Ohio

LPG for Motor Fuel

Is your staff making any studies as to the rate of growth in the change-over from motor gasoline to propane fuel by trucks, buses and tractors in this country? The rate of this change is surprisingly high, particularly with tractors, and I'm wondering if the next 5 years won't see considerable motor fuel turned back to the automotive market.

A thought on another line. If the automotive industry continues to push up compression ratios, forcing additional cracking, and does not build at least 25% fuel economy into cars at the same time, where will motor fuel supplies come from. There are 40,000,000 vehicles on the road today and automobile men say there will be 50-55,000,000 by 1960. That is going to take a lot of gasoline.

WILLIAM F. LOWE
Secretary
Natural Gasoline Assn. of America
Tulsa, Okla.

More Storage Required

Your comment in PETROLEUM PROCESSING ["Refining Trends," June, p. 663] concerning the heating oil inventory problem is of considerable interest, and we on the West Coast have become increasingly aware of it in recent months. It would not be surprising to us to see a movement of heating oils from California to the Atlantic Seaboard develop because, while eastern stocks are low, supplies on the West Coast, though not burdensome, are greater than needed to meet local demands.

The problem of supplying sufficient heating oils to meet demands in the eastern part of the country has in recent years been magnified by the rapid growth in consumption of this product relative to other principal

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They have an extensive line to draw on, too. They make unbiased recommendations between Centrifugals and Rotary Positives—we're the only company offering this *dual choice*. With capacities ranging from 5 cfm to 100,000 cfm, we can supply standard units closely matched to the job, for efficiency and economy.

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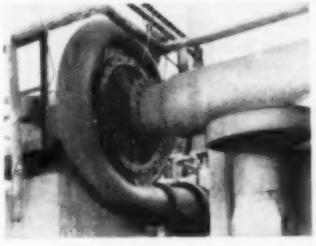
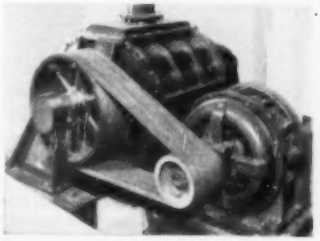
CENTRIFUGAL

Type OI, Single-stage Centrifugal Blower for outdoor operation at oil refinery. Capacity 11,750 cfm.





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R-C Rotary Positive Blower used in oil processing. Capacity 3,160 cfm.

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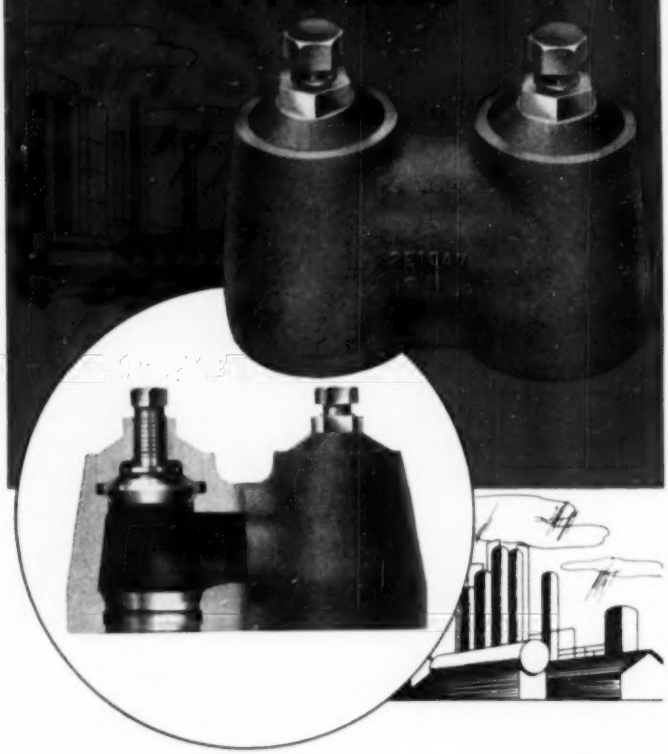

For several years Ohio Steel has been supplying their Type 3000 screw-lock fitting to refineries in many parts of the world. The cutaway view shows the strong, positive holding mechanism. This safe, simple assembly has a short, plug seat for easy removal. Ohio's Type 3000 is especially recommended where stainless steel is required for highly corrosive service.

The design of this fitting lends itself to Ohio's directional solidification casting principle.

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products and the resulting intensification of the seasonal swings in total petroleum product demands. It is becoming increasingly clear that the industry, or secondary suppliers, east of the Rockies require larger storage facilities to enable demands to be met with stable year-around refining operations.

MAX LORIMORE
Assistant Comptroller
Union Oil Co. of California
Los Angeles

Even More Important Now

(The letter below was written before war flared up in Korea)

It is important that heating oil stocks in this country be built up during this summer to a level at least equal to that which prevailed at the opening of the last heating season. It would be unwise to assume that the weather next winter, or any future winter, will be milder than normal or that the last two heating seasons should now be considered as normal in estimating future winter requirements.

In addition to the adjustments necessary to meet the changing weather conditions, there has been a serious shift in the pattern of wholesale buying of petroleum products. Greater dependence is being placed upon refiners to meet sudden and drastic changes in petroleum consumer demands. Petroleum storage capacity must be increased at all levels to assure availability to consumers in all localities under any prevailing condition.

Heating oil stocks at present are low and, unless the rate of accumulation during the summer is stepped up and an increasing number of storage units are provided throughout the country and made ready to supply the ever-increasing consumer demands, local shortages, no matter how small, will be translated into more steps toward government control and a long series of congressional investigations when the industry might be hard pressed to keep the home fires burning.

JAMES V. BROWN
Secretary-Treasurer
National Petroleum Council
Washington, D. C.

NLGI Meeting

The July issue of PETROLEUM PROCESSING [p. 749] carried our Annual Meeting dates as Oct. 3-6 in New Orleans and Oct. 30, 31 and Nov. 1 in Chicago.

Our last year's meeting was in New Orleans. . . . This year's meeting will be held at the Edgewater Beach Hotel in Chicago on Oct. 30, 31 and Nov. 1.

HARRY F. BENNETTS
Executive Secretary
National Lubricating Grease Institute, Kansas City, Kans.

[To obtain more data on advertised products see page 882]

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MAINTENANCE costs drop to a new low; valve efficiency is tremendously increased; operation is vastly improved—by the using of Rockwell Hypermatic lubricant in Nordstrom valves. Leakage is positively prevented by keeping the valves in a 100% lubricated condition—and with less frequent relubrication. In all of your Nordstrom valves, use Hypermatic.

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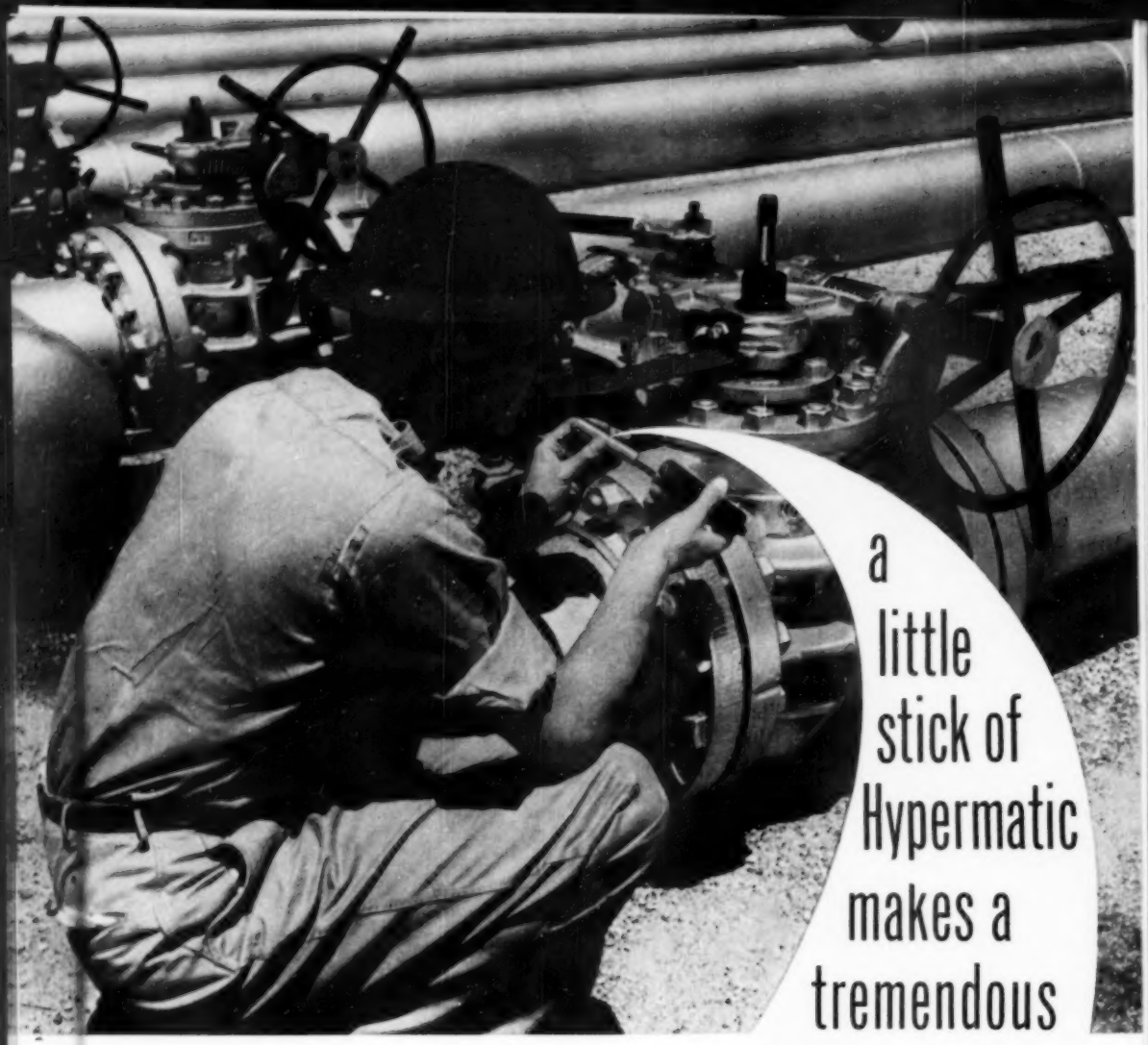
Nordstrom VALVES *Automatically Lubricated*



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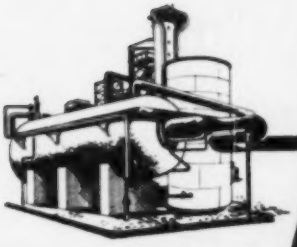

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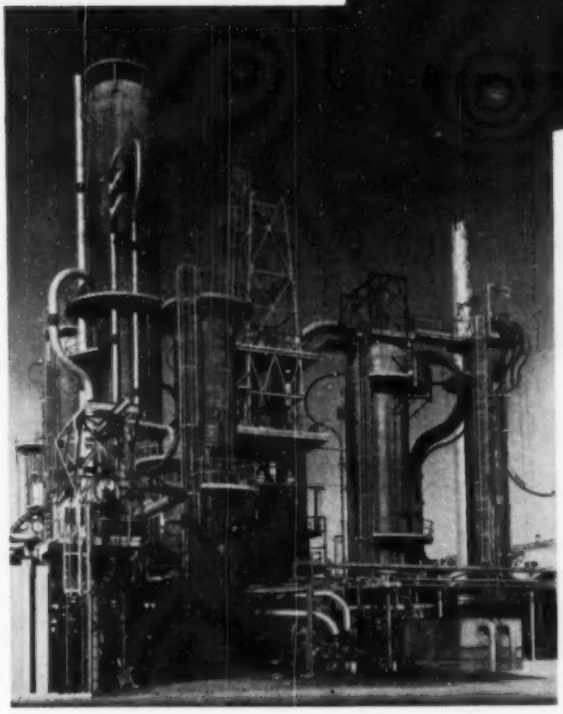

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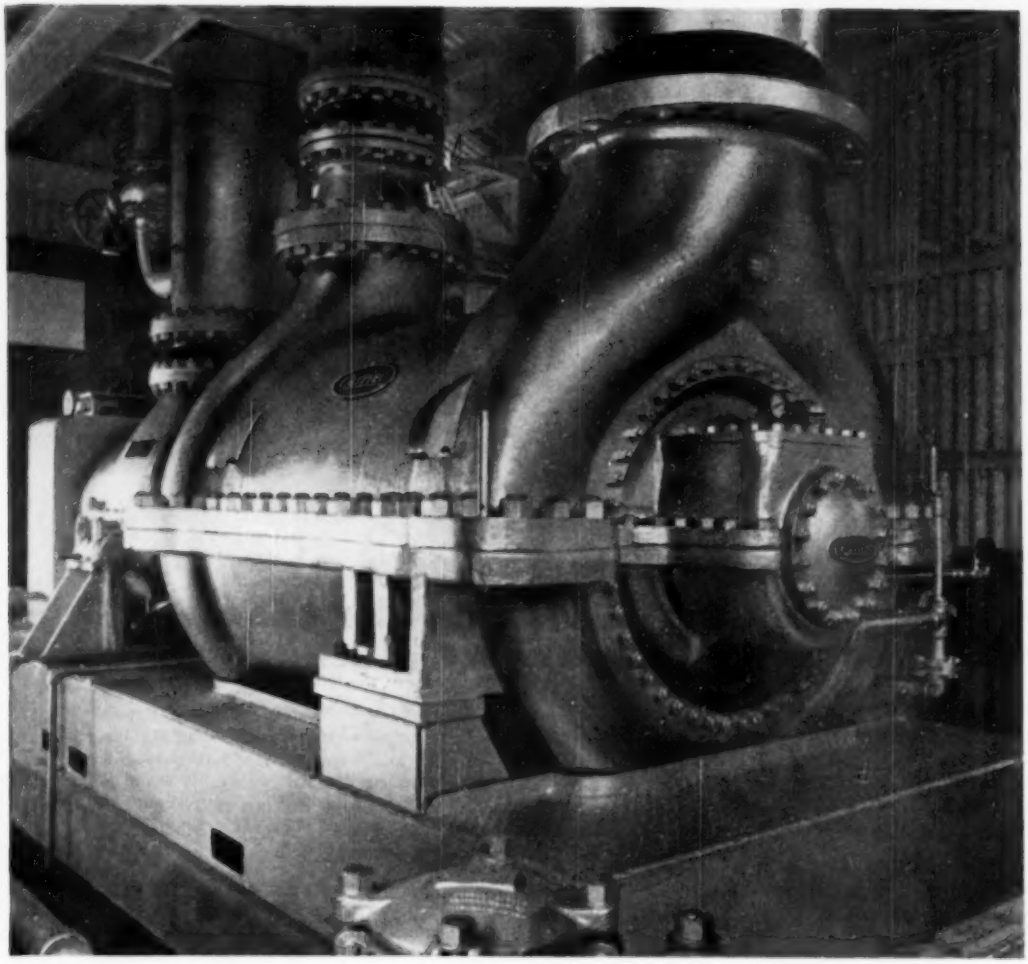
SIZE RANGE OF GLOBE SEAMLESS WELDING FITTINGS

Description of Fitting	Standard Weight (Schedule 40)	Extra Strong (Schedule 80)	(Schedule 160)	Double Extra Strong
Elbows 45° Long Radius	½ in. to 24 in.	¼ in. to 24 in.	1 in. to 12 in.	1 in. to 8 in.
Elbows 90° Long Radius	½ in. to 24 in.	¼ in. to 24 in.	1 in. to 12 in.	1 in. to 8 in.
Elbows 90° Short Radius	1 in. to 24 in.	1½ in. to 24 in.	- - -	- - -
Returns 180° Long Radius	½ in. to 24 in.	1 in. to 24 in.	1 in. to 12 in.	3 in. to 8 in.
Returns 180° Short Radius	1 in. to 24 in.	1½ in. to 24 in.	- - -	- - -
Reducers (Concentric and Eccentric)	1 x ⅜ in. to 24 x 20 in.	1 x ⅜ in. to 24 x 20 in.	1 x ⅜ in. to 12 x 10 in.	1 x ⅜ in. to 12 x 10 in.
Tees Straight	¼ in. to 24 in.	⅜ in. to 24 in.	1 in. to 12 in.	1 in. to 8 in.
Tees Reducing Outlet	¼ in. to 24 in.	⅜ in. to 24 in.	1 in. to 12 in.	1 in. to 8 in.
Stub Ends Lap Joint	1 in. to 24 in.	1 in. to 24 in.	- - -	- - -
Caps	1 in. to 24 in.	1 in. to 24 in.	1 in. to 12 in.	1 in. to 8 in.

Flanges available 1 inch to 24 inches in all weights



CONOCO

Chooses Carrier Centrifugal Compressor for "Cat Cracker"

The fluid catalytic cracking unit at the Billings, Montana, refinery of the Continental Oil Company is supplied with air from this Carrier Compressor.

The compressor is direct-connected to a condensing steam turbine. The complete unit is mounted on a fabricated structural steel base.

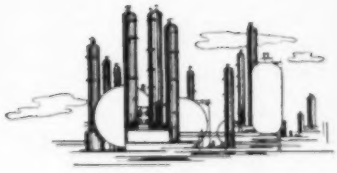
Steam for driving the Carrier Centrifugal may be supplemented from the waste heat boiler on the "cat cracker." Because the Carrier Centrifugal produces a steady stream of air in large volumes with no pulsation, piping and manifolding costs are reduced.

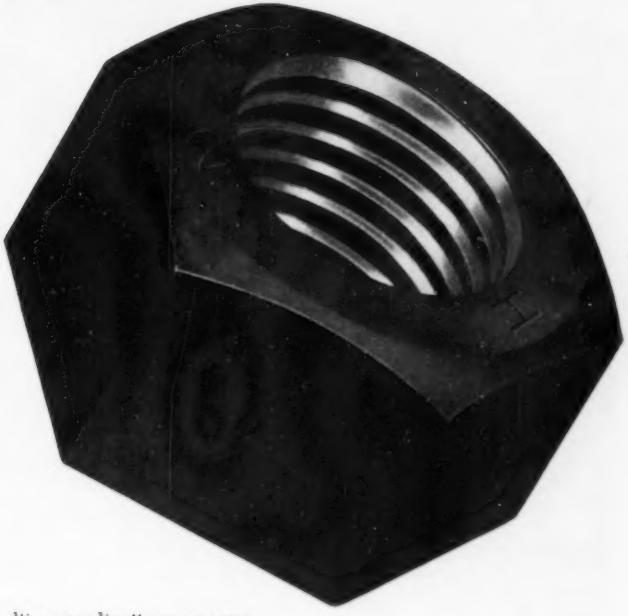
The design of the Carrier Compressor is simple. There is only one major moving part. The casing is cast from close-grained semi-steel. The rotor blades are matched to insure static balance. Then the forged shaft and impellers are progressively balanced —statically and dynamically—prior to assembly.

Construction like this insures fine operation and dependability. Carrier Centrifugal Compressors built over 25 years ago are still operating efficiently. Carrier Corporation, Syracuse, N. Y.

Carrier CENTRIFUGAL COMPRESSORS • REFRIGERATING EQUIPMENT

It's at its best when the going is TOUGH





For the high-temperature, high-pressure bolting applications encountered in refineries, it pays to put the Bethlehem Quenched Nut to work For this economical nut can take it. In fact, it's at its best when the going is tough.

The Bethlehem Quenched Nut has the ability to withstand difficult bolting conditions because it is hot forged. Instead of being punched from a hot bar, like ordinary nuts, the Quenched Nut is formed by forging and extruding hot metal into a forming die. This is followed by quenching and tempering. What's the result? A nut strong enough to break virtually any stud or bolt on which it is used.

The Bethlehem Quenched Nut also has a tough grain structure. Besides, its oxidized sides put up a good fight against atmospheric corrosion, and its ground bearing surface is definitely superior to common, machined surfaces.

The Quenched Nut is made at Bethlehem's Lebanon, Pa., plant. It conforms to Grade 2H of ASTM Specification A194, and is carried in stock in bolt sizes from $\frac{3}{8}$ in. to $3\frac{1}{2}$ in. Also carried in stock at Lebanon are nuts in Grades 0, 1, 2, and 4. For additional details about the Quenched Nut, call in a Bethlehem man, or write to us at Bethlehem, Pa.

BETHLEHEM STEEL COMPANY
BETHLEHEM, PA.

On the Pacific Coast Bethlehem products are sold by Bethlehem Pacific Coast Steel Corporation. Export Distributor: Bethlehem Steel Export Corporation.

BETHLEHEM STEEL

Bethlehem supplies every type of Fastener

This 22-Foot Hartzell Cooling Tower Fan Can Give You .... 1,250,000 C.F.M.

★

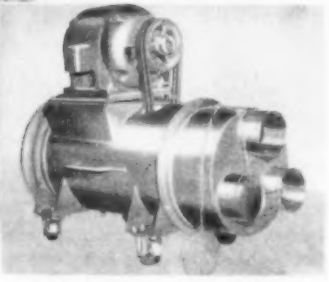
Not one Hartzell Cooling Tower Fan of Hartzite Plastic has ever failed unless obviously abused . . .

NOT ONE

Shown on the Hartzell test stand is the new Hartzell 22-foot Cooling Tower Fan. Blades are of Hartzite plastic, which has proved itself to refiners so convincingly on Hartzell fans up to 20-foot diameter. It was run continuously at 125% of its rated speed on test; stresses developed were 55% greater than are encountered in service. It delivered 1,250,000 cfm at 180 HP.

This truly great new fan, on which we are now making deliveries in the sequence in which orders are received, will give you maximum cooling power per cubic foot of tower. Power cost per cubic foot of air moved is relatively low.

If you build or buy cooling towers using fans of 3' to 22' size, specify Hartzell. If you've had trouble with fans in existing towers, replace with Hartzell. Your troubles will end!



PORTABLE BLOWER CLEARS FUMES FROM TANKS

Shown above is a Hartzell Vaneaxial Blower "on casters." Easily lifted by two men; compact, powerful. Specially mounted by Hartzell to clear fumes from gasoline tank trucks before and during interior welding repairs. Each of three portholes, any or all of which can be used at one time, delivers approximately 500 cfm through a 15-foot long 5" hose. End assemblies easily reversible for exhausting or blowing. Other capacities can be produced.

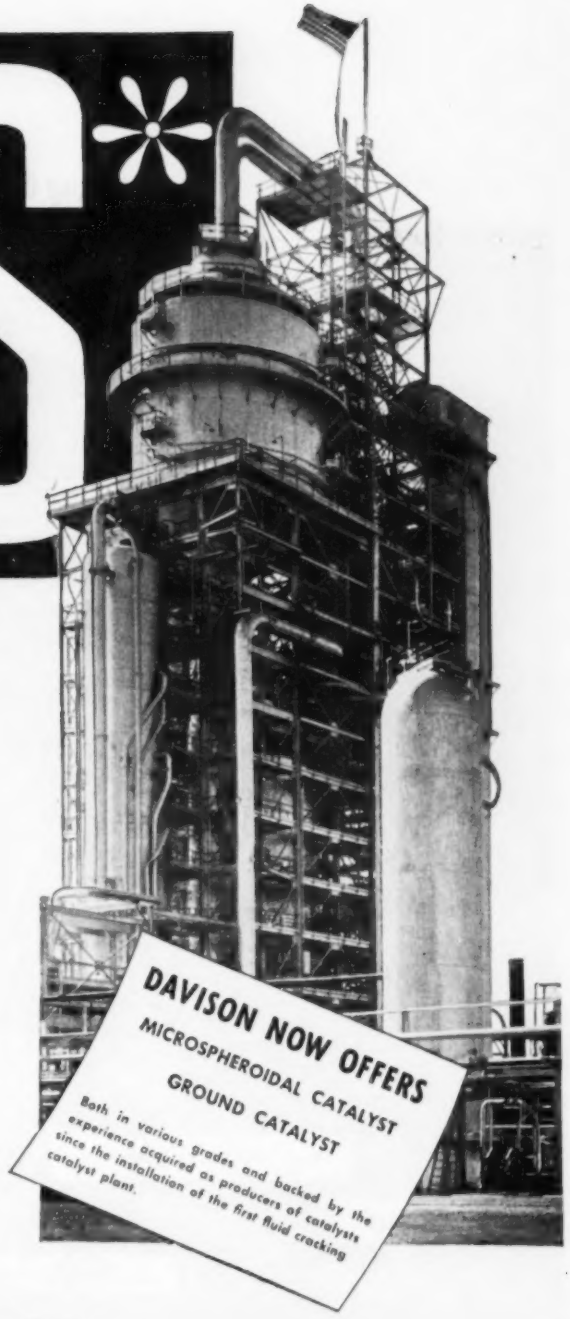
CLIP AND MAIL COUPON NOW FOR INFORMATION

HARTZELL PROPELLER FAN CO.
Div. of Castle Hills Corp.
PIQUA DEPT. K OHIO

Name_____
Company_____
Street & No._____
City & State_____

PROPELLER-TYPE FANS AND BLOWERS — ROOF VENTILATORS — UNIT HEATERS • ENGINEERING OFFICES IN PRINCIPAL CITIES

M·S*


DAVISON NOW OFFERS
MICROSPHEROIDAL CATALYST
GROUND CATALYST
Both in various grades and backed by the experience acquired as producers of catalysts since the installation of the first fluid cracking catalyst plant.

DAVISON MICROSPHEROIDAL CATALYST

In order to serve the petroleum industry's needs for synthetic fluid type cracking catalyst in microspheroidal form, Davison is installing spray drying facilities in its Cincinnati, Ohio catalyst plant. The installation is scheduled for completion by October, 1950.

The new equipment includes the largest spray drying chamber yet installed for the purpose of making petroleum cracking catalyst. It will be capable of producing several grades of catalyst in microspheroidal form, each having unusually favorable particle size distribution.

The chamber will be built entirely of stainless steel; and with other special processing equipment, the catalyst produced will equal the high standards of quality inherent in all Davison products.

Now, your requirements for fluid synthetic cracking catalyst can be supplied by Davison in either microspheroidal or ground form and you can depend on Davison for reliable and cooperative service.

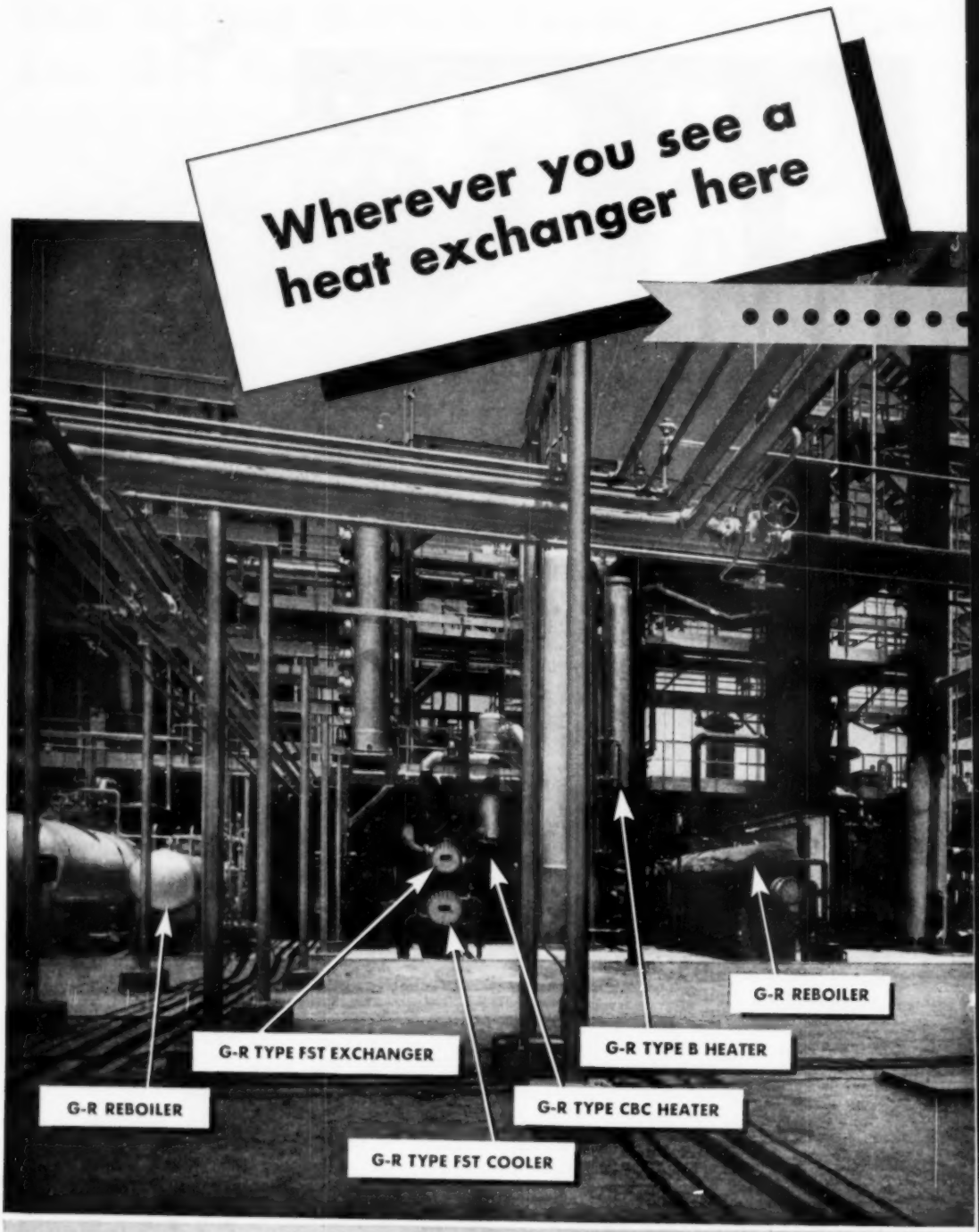
* T.M. T.D.C.C.

PROGRESS THROUGH CHEMISTRY

THE DAVISON CHEMICAL CORPORATION

Baltimore 3, Maryland

[*To obtain more data on advertised products see page* 882]



GRISCOM-RUSSELL • PIONEERS IN HEAT TRANSFER APPARATUS

...it's a G-R unit

This Badger-built plant is a model of top-notch engineering and construction. To help make it so, G-R Exchangers, Coolers, Heaters and Reboilers are used, because of the proven excellence of G-R Heat Transfer Apparatus.

Here, as in other petroleum refining and chemical process plants all over the world, G-R Heat Transfer apparatus was selected to assure maximum effectiveness at minimum operating and maintenance cost.

G-R designs include bare tube and finned tube units for every heat transfer requirement, based on our unequalled specialized experience of more than 80 years. Each G-R unit has many exclusive and distinctive features which have been developed through continuous pioneering and which are unobtainable in other designs.

Write for bulletins describing heat transfer units in which you are interested, and be sure to consult the G-R engineers for your particular needs.

THE GRISCOM-RUSSELL CO.
285 MADISON AVE., NEW YORK 17, N. Y.

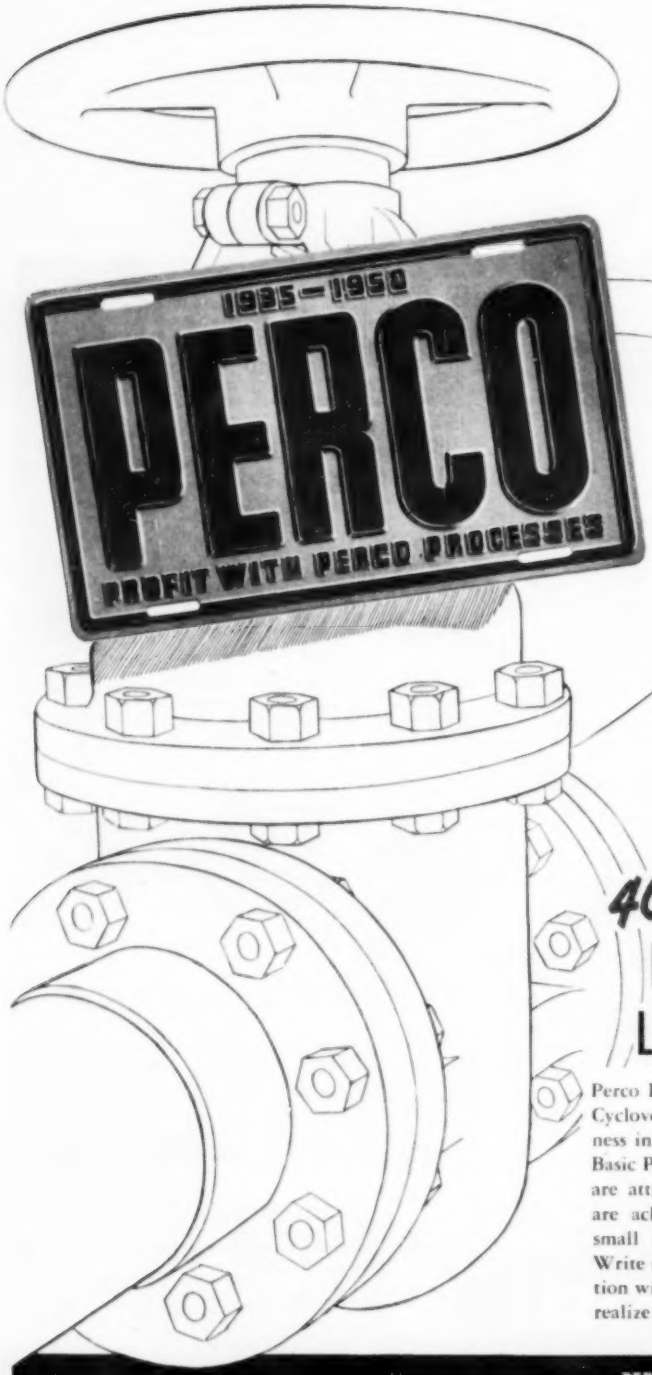
G-R TUBULAR EXCHANGER
A shell-and-tube unit with many distinctive features for efficient performance with minimum attendance and maintenance expense.

G-R REBOILER
Widely used in process industries, and available with either bare tubes or K-Fin helically finned elements.

G-R TYPE B HEATER
A simple, practical design, highly efficient on moderate pressure, moderate temperature duties.

GRISCOM-RUSSELL

GR-251

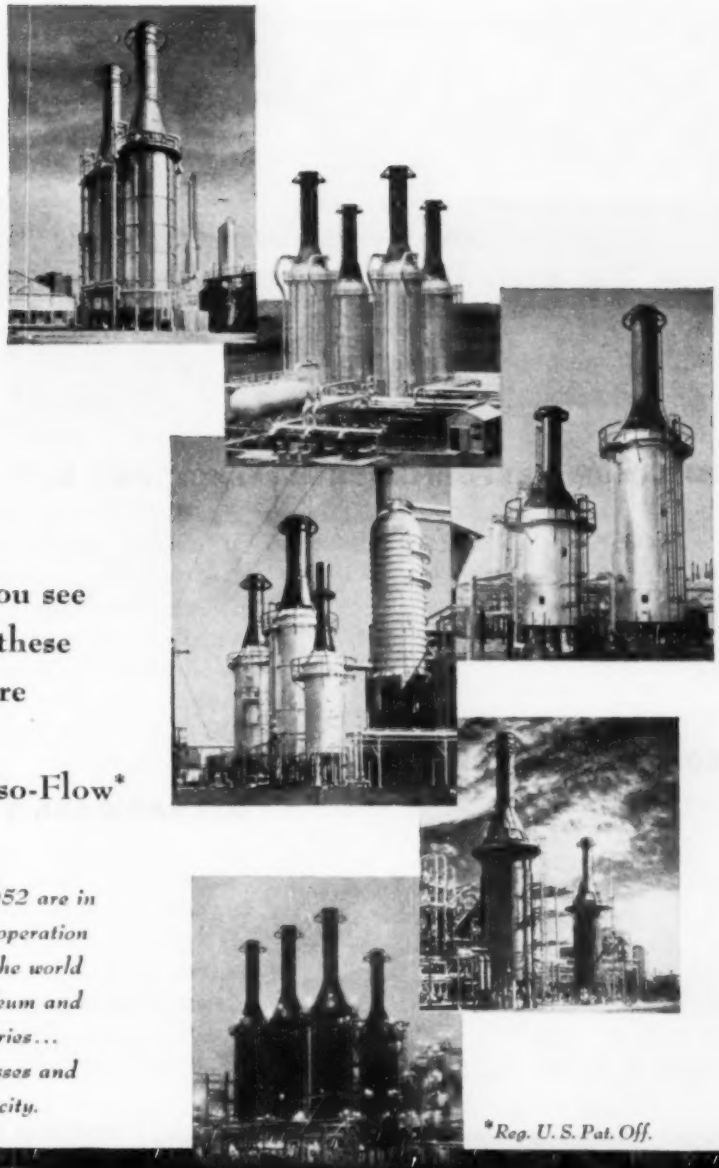


OVER 400,000 BARRELS DAILY THROUGHPUT LICENSED BY PERCO*

Perco Processes, such as Copper Sweetening and Cycloversion*, are proving their daily effectiveness in all sizes of refineries and gasoline plants. Basic Perco designs are simple. Construction costs are attractively low. High operating efficiencies are achieved and maintained with remarkably small manpower and instrumentation control. Write us for information on how a Perco installation will integrate with your facilities to help you realize more profit from your daily throughput.

*A SERVICE MARK

PERCO DIVISION
PHILLIPS PETROLEUM COMPANY
BARTLESVILLE, OKLAHOMA



Whenever you see furnaces like these you can be sure they're Petro-Chem Iso-Flow* design

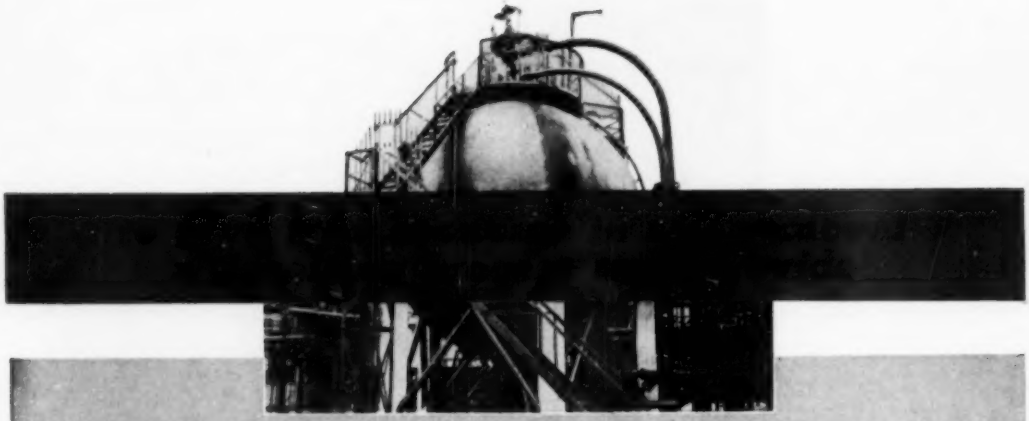
More than 652 are in satisfactory operation throughout the world in the petroleum and allied industries... for all processes and for any capacity.

*Reg. U. S. Pat. Off.

PETRO CHEM
ISO-FLOW FURNACES
UNLIMITED IN SIZE . . CAPACITY . . DUTY
PETRO-CHEM DEVELOPMENT CO., INCORPORATED
120 EAST 41ST STREET, NEW YORK 17, N. Y.

Representatives: Bethlehem Supply, Tulsa and Houston - Flagg, Brackett & Dwyer, Boston - D. D. Foster, Pittsburgh - Fayette Lovatty, Chicago - Lester Oberholtz, California

There's a Petro-Chem Iso-Flow Furnace and Boiler for every service, capacity or duty, irrespective of temperature pressure ranges . . . none too small or too large . . . more than 652 in operation throughout the world in the petroleum and allied industries performing with utmost satisfaction . . . and in many instances operating in excess of their design capacity by more than 50%.



MAXIMUM PERFORMANCE...

Getting "most of the salt" is not enough. In every installation Petreco engineers aim at 100% removal — and they're getting it, or closely approaching it, time after time. Some Petreco users now install desalters to treat crudes considered "comparatively salt free" only a few years ago. *Maximum salt removal permits top refining efficiency—you get PERFORMANCE with PETRECO.*

COMPETENT SERVICE...

Petreco engineers supervise construction on every installation. Petreco resident engineers are on 24-hour emergency call. Petreco research technicians and laboratory facilities are always ready to assist refiners on salt problems. Petreco engineers regularly inspect the desalting equipment and check its performance. Petreco warehouses replacement parts close to all major refining centers. *You get SERVICE with PETRECO.*

FAST PAY OUT...

One refiner states that Petreco Desalting "paid out" in *three months!* Another cited a *five months* payout. Payouts such as these represent substantial savings for any refiner charging salty crudes. The reasons most frequently cited for Petreco's fast payout are: Less plugging in crude furnaces, heat exchangers and reduced crude furnaces; less corrosion in topping units. *You get FAST PAY-OUT with PETRECO.*

OPERATIONAL FACTS...

If you have a desalting problem, ask Petreco for facts and figures—Petreco engineers can tell you why Petreco desalters deliver such high removal percentages, how Petreco Service is designed to help you, and why, how and where Petreco Desalters have more than paid their own way. *Get facts! They're available from*

PETROLEUM RECTIFYING COMPANY

5121 SO. WAYSIDE DR., HOUSTON 1, TEXAS
1390 E. BURNETT ST., LONG BEACH, CALIF.

PETRECO

SPECIALIZED *Electric* PETROLEUM PROCESSES { DESALTING / DEHYDRATING

PR 50-2

Avoid "DOWN-TIME" for Maintenance—Standardize on the POWELL LINE

When you buy a valve, ask yourself these two questions. First, will it operate satisfactorily in the service in which it is to be used? Second, and of most importance, how much *maintenance* will it require? Because, every time maintenance becomes necessary, there's a two-fold cost. One, the cost of labor—and possibly parts—to put it back in working order. Two, the loss of production farther down the line.

And, because Powell Engineers *always* have this in mind, every valve in the *complete* Powell Line* is designed and made to avoid, as far as possible, "DOWN-TIME" for maintenance.

That's why, through the years, Powell Valves have been noted for long, trouble-free performance—even under the most exacting service conditions.

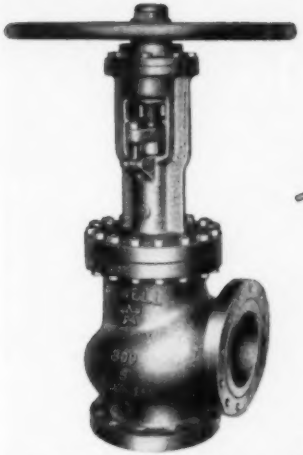


Fig. 3033—Class 300-pound Cast Alloy Steel Angle Valve with flanged ends, outside screw rising stem and bolted flanged yoke. The streamlined areas through the body assure maximum flow with minimum pressure drop. Built to handle temperatures up to 1400 F.

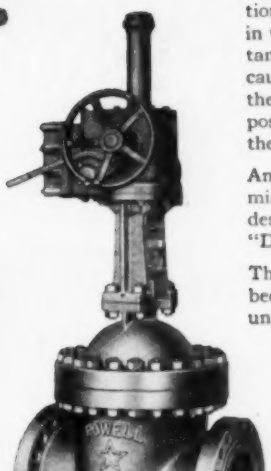


Fig. 6079—Motor Operated Class 600-pound Cast Steel Gate Valve for Pipe Line Service. Has flanged ends and bolted flanged bonnet. Classes 150, 300, and 400-pound valves can be furnished. Also available with gears.

Fig. 375—200-pound Bronze Gate Valve. Screwed ends, union bonnet, inside screw rising stem and renewable "Powellium" wear-resisting nickel-bronze disc.

Fig. 1793—Large 125-pound Iron Body Bronze Mounted Gate Valve with flanged ends, bolted flanged yoke, outside screw rising stem and tapered solid wedge.

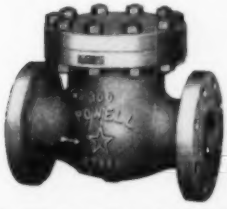


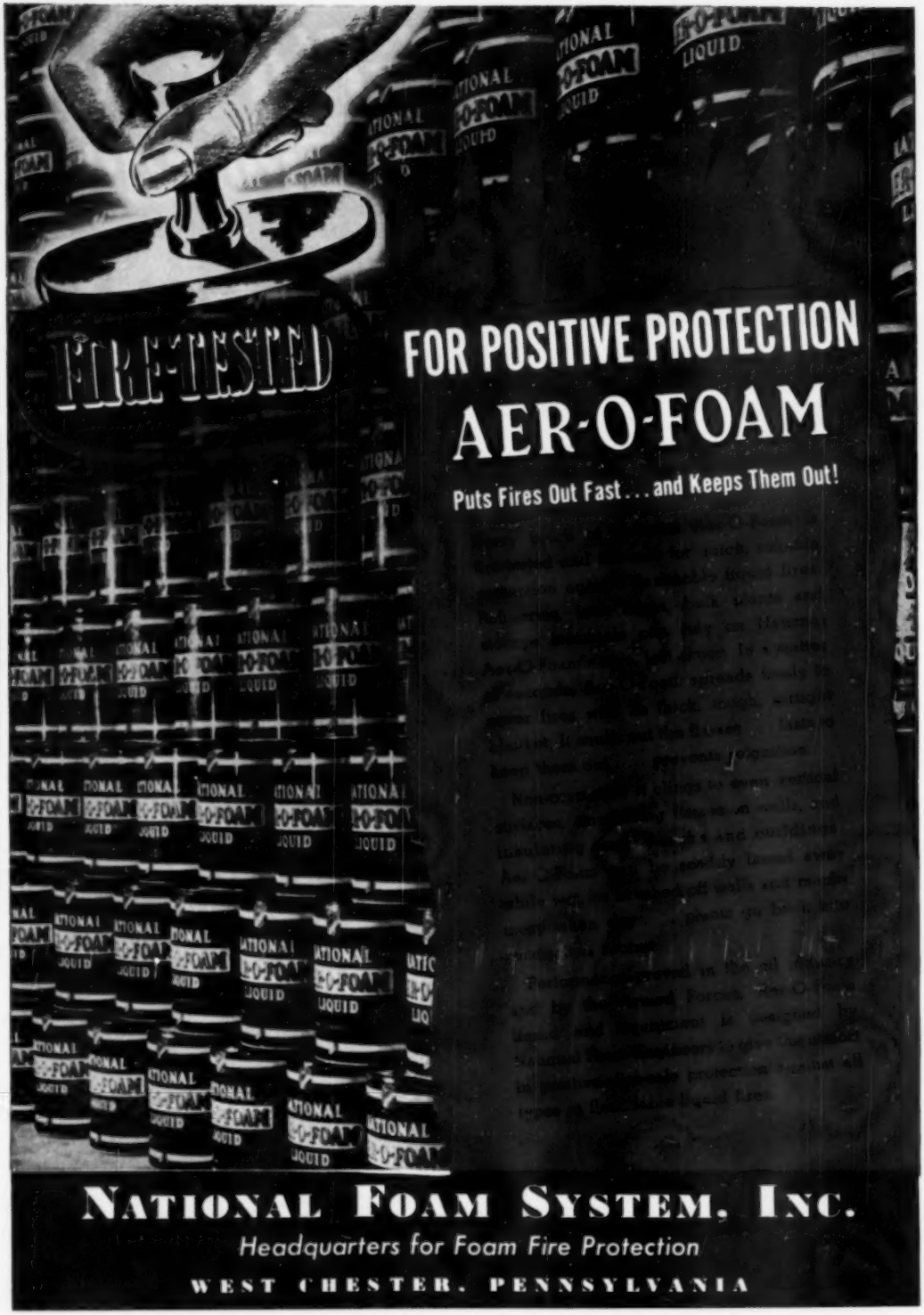
Fig. 3061—Class 300-pound Cast Steel Swing Check Valve with flanged ends and bolted cap. Disc has ample lift to permit full, straightway, unobstructed flow through the valve body.

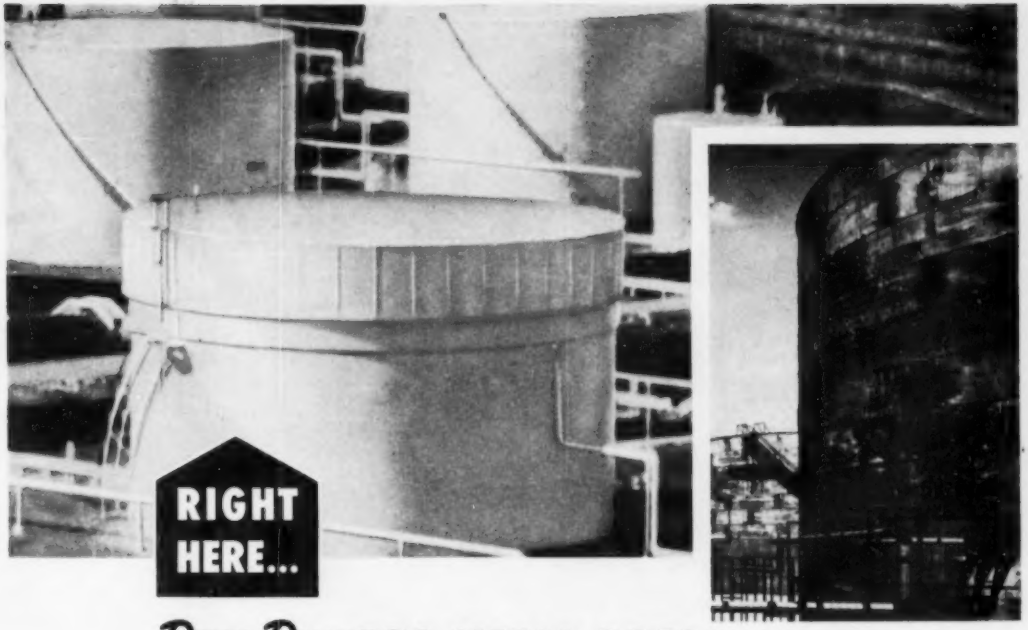
***The Complete Powell Line includes Globe, Angle, "Y", Gate, Check, Non-return, Relief, and Flush Bottom Tank Valves in Bronze, Iron, Steel and a wide range of Corrosion-resistant metals and alloys.**

Ask your nearest Distributor—or write direct

The WM. POWELL Co., 2525 Spring Grove Ave.
P. O. Box 106, Station B, Cincinnati 22, Ohio
DISTRIBUTORS AND STOCKS IN ALL PRINCIPAL CITIES

POWELL VALVES


FIRE-TESTED
FOR POSITIVE PROTECTION
AER-O-FOAM
Puts Fires Out Fast . . . and Keeps Them Out!
NATIONAL FOAM SYSTEM, INC.
Headquarters for Foam Fire Protection
WEST CHESTER, PENNSYLVANIA



Dum Dum FOR METAL DOES WHAT PAINT CAN NEVER DO!

This thick, tough, elastic coating (not a paint) stands up against every kind of corrosive element; combats industrial fumes and gases, sun and rain, freeze and thaw for years and years. It does what even the best of metal protective paints (which we make, of course) can never do.

Can you afford to paint?

If you buy materials with an eye on length of service, you can't afford to take chances with temporary protection. Not when Dum Dum for Metal gives more lasting protection over the long haul than any other protective coating.

See for yourself!

You'll find experienced appliers of Dum Dum for Metal no matter where you do business. For complete information on how Dum Dum for Metal can solve your tank maintenance problem... write, wire or phone Arco today. Ask for the interesting, informative booklet, available without charge or obligation, which gives all the facts about Dum Dum for Metal. Address Dept. P-5.

"Dum Dum" is a registered trademark of The Arco Company.

Dum Dum FOR METAL'S MANY ADVANTAGES

MORE THAN A PAINT—Dum Dum for Metal is spray-applied in a thick, tough but elastic coating many times the thickness of paint. It adheres to metal surfaces regardless of shape or contour.

NO MOISTURE SEEPAGE... NO MOISTURE VAPOR TRANSMISSION—Most paint films become porous in time and allow direct seepage of moisture. Dum Dum for Metal sets up a "vapor barrier"... keeps out not only moisture, but also *moisture vapor*.

STAYS PLIABLE—Dum Dum for Metal's outer surface sets up with a tough skin while the undersurface remains pliable and elastic.

HEALS ITSELF—Should Dum Dum for Metal's tough outer surface be bruised or broken, the pliable undersurface skins over where exposed and heals itself.

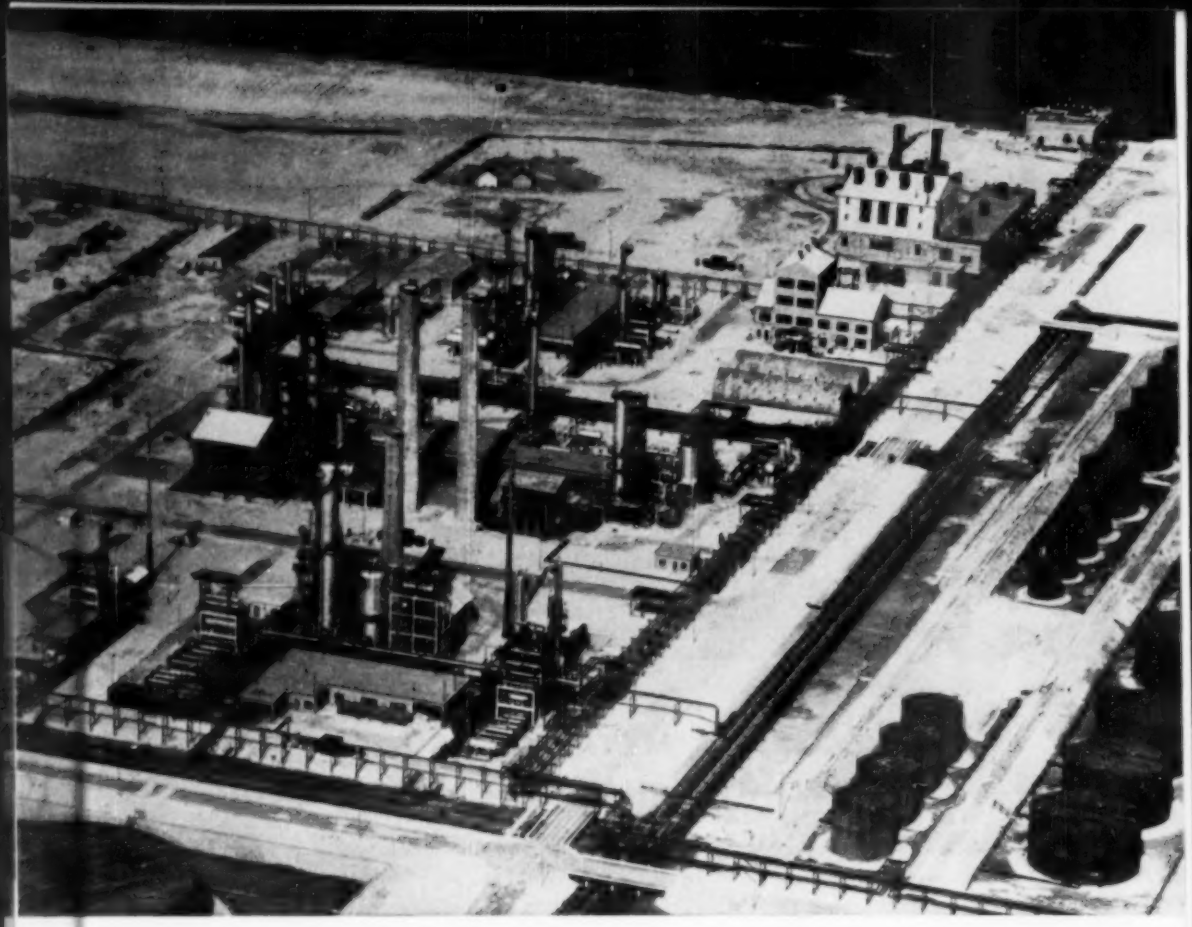
ARCO
SINCE 1881

Paints, Lacquers, Varnishes, Enamels, Protective Coatings
TRADE MARK

TESTED FIRST TO MAKE IT LAST!

THE ARCO COMPANY • CLEVELAND • LOS ANGELES

[*To obtain more data on advertised products see page* 882]



NEW 20,000 BARREL CALTEX HOLLAND REFINERY

Engineered and Constructed by

ARTHUR G. McKEE & COMPANY

This complete refinery, one of the most modern in Europe, is a typical example of the world-wide design, engineering and construction services provided by the McKee organization.

ARTHUR G. McKEE & COMPANY

DESIGN, ENGINEERING AND CONSTRUCTION FOR THE PETROLEUM REFINING AND IRON AND STEEL INDUSTRIES

ENGINEERS AND CONTRACTORS • ESTABLISHED 1905
2300 CHESTER AVENUE, CLEVELAND
30 Rockefeller Plaza, New York, N. Y.

DU PONT

REG. U.S. PAT. OFF.

BETTER THINGS FOR BETTER LIVING

. . . THROUGH CHEMISTRY

DU PONT SERVICES

meet the specific needs of the refiner

IN RESEARCH

IN MANUFACTURING

IN MARKETING

USE DU PONT TETRAETHYL LEAD COMPOUNDS

Meet your friends at
THE OIL INDUSTRY SERVICE CENTER
CHICAGO FAIR OF 1950

These Du Pont Services are Applicable to Your Problems

To aid the refiner in the most effective use of a complete line of gasoline additives, Du Pont provides an extensive service program. The following outline highlights where some of these services are of aid.

IN RESEARCH

Research Helps Match Fuels and Additives to Engine Needs—In the Du Pont Petroleum and other laboratories research effort is being directed at those problems of the refiner which involve development of new fuels and better combustion control.

Problems Under Investigation — Among specific studies being made are the following:

Combustion Reactions — Investigating the chemical changes that take place in the air-fuel mixture under pressure just prior to combustion and during combustion.

Deposit Studies—Research into the chemical nature of engine deposits.

Sulfur in Gasoline—The how and why of sulfur effect upon octane number of leaded fuels.

Effect of Fuel Components on Performance—Research, recently completed, provides information on the blending of fuel components as they affect TEL requirements and performance.

Du Pont Research Is of Use—Significant findings on research projects are made known to refiners:

Through Publication of Papers—Papers on research results are presented at technical society meetings.

Through Meetings with Refinery Research Groups—Members of the Du Pont research staff discuss projects under investigation in meetings with a refiner's own research group.

Company-wide Research – Findings of other Du Pont research laboratories are available at all times to the Petroleum Chemicals Division for consideration as to their application to the petroleum industry.

IN MANUFACTURING

Aid in the Most Effective Use of Additives—Du Pont provides a complete range of services that function within the refinery.

TEL Blending—Du Pont representatives are thoroughly familiar with requirements as they apply to men, equipment and methods.

Blending Plant Design, Construction—Complete construction drawings and specifications for blending plants, as well as advisory help on plant site selection and construction, are available.

Blending Plant Operation—Du Pont representatives aid in the training of operating personnel.

Maintenance and Repair—Assistance is always available when repairs must be made.

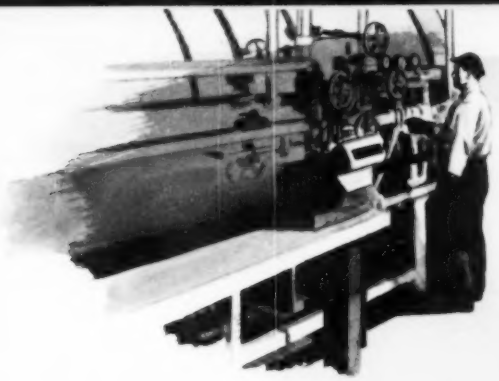
Tank Entries—Petroleum Chemicals representatives will attend and advise on cleaning of tanks that have contained leaded gasoline.

General Refinery Safety Program—An over-all refinery safety program prepared by Du Pont is available to any refiner.

Field Laboratory Services Work on Many Problems—Five Field Laboratories throughout the country assist on problems involving the use of additives.

TEL Blending Studies—These laboratories are equipped to make TEL analyses and blending studies on gasoline stocks.

Octane Ratings—They also make routine octane ratings quickly and accurately.



Gasoline Quality Survey — The laboratories cooperate with refiners in nation-wide sampling and local evaluation of their fuel.

Assistance with Other Additives—Recommendations on the use of Du Pont Gasoline Antioxidants, Metal Deactivator, Gasoline Dyes and other additives are also available through the laboratories.

•

IN MARKETING

Services Helpful in Dealer Training and Sales Planning—These services are designed to supplement and strengthen the individual refiner's own promotional efforts by supplying assistance at those points where it is felt Du Pont can be of most help.

For Dealer Education—To aid you in keeping your dealers better informed on the sales qualities of your fuels, Du Pont offers the following aids:

Informative Talks — Non-technical or semi-technical talks for dealer meetings.

Cartoon Movie—A seventeen-minute, four-color, cartoon movie, understandable to any group, "What Makes A Gasoline Good?"

Cartoon Book—A 16-page cartoon book in full color telling the same story.

Instructive Laboratory Meetings—Tours of the Du Pont Field Laboratories and meetings for refinery sales engineers or marketing groups.

To Aid in Planning Sales—Factual information on gasolines being marketed throughout the country is provided by:

Quarterly Motor Gasoline Survey—Individual brands, premium and regular, are listed by code number together with their motor and research octane numbers, and the lead content per gallon. City averages are also shown.

Other Marketing Aids—Assistance is also available in meeting the problems of your customers.

Traveling Fuel Test Fleet — Demonstrates the importance of gasoline quality to car performance through actual demonstrations of road test techniques.

Services to Fleet and Bus Users of Your Fuels—Du Pont automotive specialists are available for consultation on fleet operating problems or on any problem involving motorized equipment.

Bulletins on Equipment Operation — Based on Du Pont's laboratory and road test experience, bulletins are prepared covering various technical aspects of the equipment used.

Safety Services for Marketing Departments—Du Pont representatives are available for consultation on safety and medical problems wherever tetraethyl lead compounds are used in bulk plants or other marketing department units.

For a complete description of the services which Du Pont offers, ask your Petroleum Chemicals representative to reserve a copy for you of the 32-page book, soon off the press, "Du Pont Services to the Petroleum Industry" . . . or write your nearest Du Pont District Office.

DU PONT SUPPLIES A *Complete* LINE OF ADDITIVES FOR GASOLINE

TETRAETHYL LEAD COMPOUNDS

Du Pont Tetraethyl Lead Compounds, Aviation Mix and Motor Mix, are available on schedule to match your blending needs. Shipments are made in standard drums or tank cars. For the latter service, Du Pont maintains its own fleet of tetraethyl lead tank cars.

GASOLINE ANTIOXIDANTS

Three gasoline antioxidants are obtainable, Nos. 5, 6, and 22. Laboratory evaluation, either in your own laboratory or in the Du Pont Field Laboratories, will demonstrate which one of these three will be the most economical to use in your gasoline.

METAL DEACTIVATOR

Wherever copper, in any quantity, is present in gasoline, the use of Du Pont Metal Deactivator is recommended. It can be demonstrated by laboratory tests, and through actual case histories, that its use, in such cases, materially reduces antioxidant treating costs.

GASOLINE DYES

Du Pont Gasoline Dyes include Oil Red, Oil Yellow N, Oil Orange, and Oil Blue A. To assist in their use, the Field Laboratories provide a comprehensive dye evaluation service.

AND ADDITIVES FOR OTHER PETROLEUM PRODUCTS *AS WELL*

In addition to the complete line of gasoline additives, Du Pont supplies additives for a wide range of other petroleum products. Included among them are fuel oil stabilizers, lubricating oil corrosion inhibitors, grease inhibitors, and the like.

DID YOU KNOW?

That Du Pont has, for many years, supplied special white finishes for gasoline storage tanks? These finishes have maximum heat reflection, are specially compounded for their resistance to weathering and to provide for self-cleaning properties.

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PETROLEUM CHEMICALS DIVISION
Wilmington 98, Delaware

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Debutanizer Reflux Accumulators
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for SOCONY-VACUUM
EAST ST. LOUIS REFINERY

■ Graver congratulates Socony-Vacuum on the completion of its modernization program at the East St. Louis refinery.

This modernization involves expansion of crude distillation facilities, revamping and expansion of thermal cracking and delayed coking operations, and a gasoline treating unit. The total refinery capacity rating will be increased about 10,000 b/d to 30,000 b/d, resulting in increased production of gasoline, kerosene and distillate fuel oils.

Graver-built equipment at this refinery performs an important role in the expansion of Socony-Vacuum service to its customers.

FABRICATED PLATE DIVISION
GRAVER TANK & MFG. CO., INC.
EAST CHICAGO, INDIANA

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NEW YORK • PHILADELPHIA • CHICAGO • CATASAUQUA, PA. • HOUSTON • SAND SPRINGS, OKLA.

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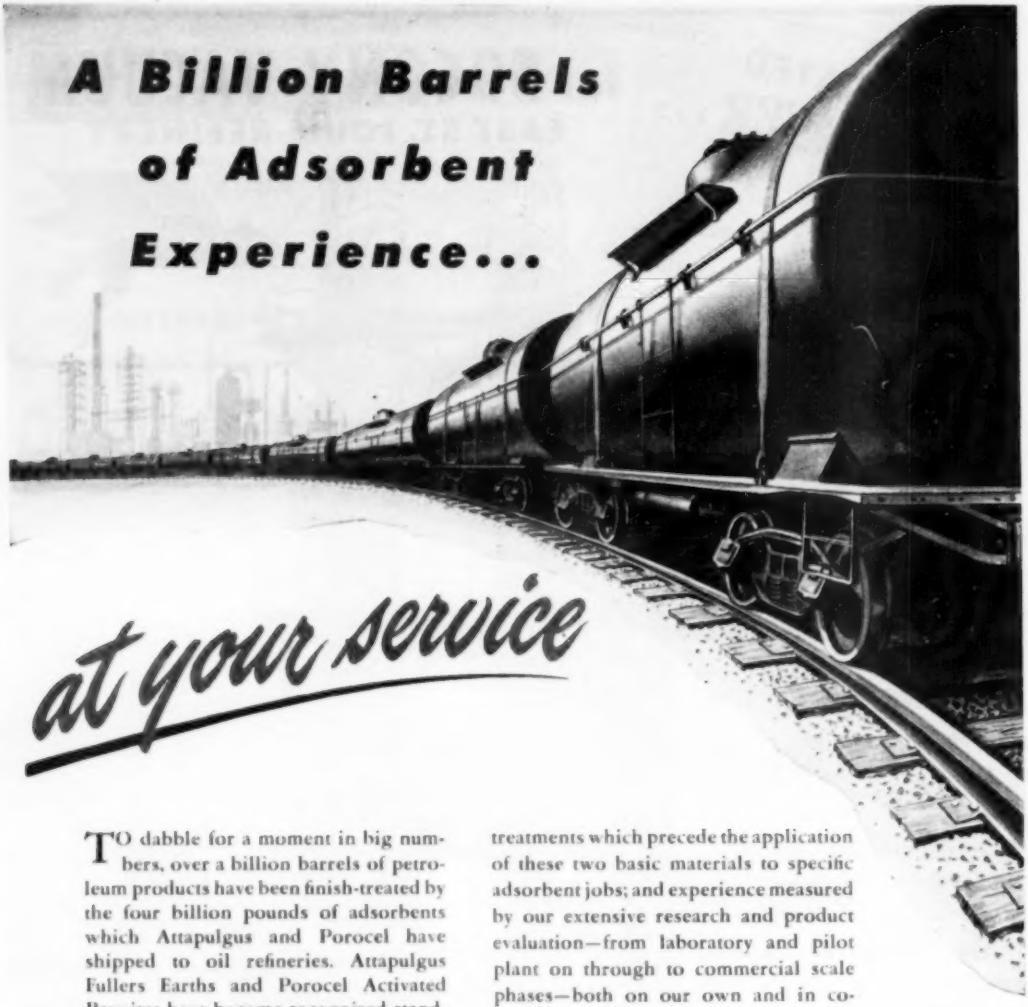

at your service

TO dabble for a moment in big numbers, over a billion barrels of petroleum products have been finish-treated by the four billion pounds of adsorbents which Attapulgus and Porocel have shipped to oil refineries. Attapulgus Fullers Earths and Porocel Activated Bauxites have become recognized standards in the removal or reduction of odors, colors, tastes, moisture, acids, sulfur, fluorides and unsaturates, and for solid catalyst purposes. And in this wide range of services, remarkable finished value was gained in a long list of petroleum cuts—from the lightest distillates to the heaviest lubes and waxes.

This all adds up to a lot of adsorbent experience—experience with the many treatments which precede the application of these two basic materials to specific adsorbent jobs; and experience measured by our extensive research and product evaluation—from laboratory and pilot plant on through to commercial scale phases—both on our own and in cooperation with our customers.

So there's great merit to the suggestion that it pays to consult Attapulgus and Porocel. In your own plans to improve products or expand output, perhaps our one billion barrels of adsorbent experience can be of real help to you in selecting the right adsorbent and the right conditions. Our laboratory and process staff are at your service, without obligation.

ATTAPULGUS CLAY COMPANY *Fullers Earth* • **POROCEL CORPORATION** *Activated Bauxites*

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This is not a part of a ship or marine vessel, nor the nose of a huge torpedo. It is a section of a 55 foot diameter oil refining unit. It is being built in our plant where a large variety of similar equipment is built each year as regular products of this plant. Note the true shape and the accurate fits. Because of our vast facilities and long experience no job is too large and "what we build we build good."

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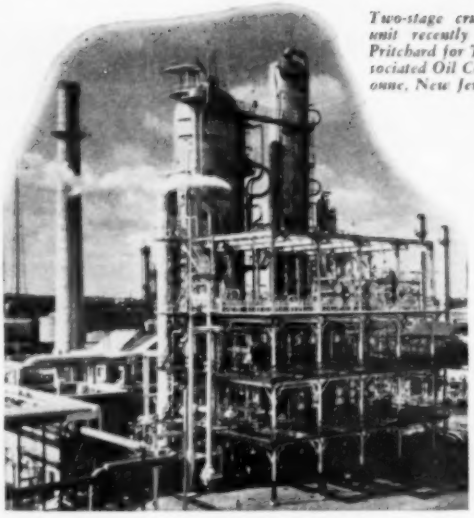

Two-stage crude distillation unit recently completed by Pritchard for Tide Water Associated Oil Company at Bayonne, New Jersey.

Pritchard Designs for Versatility and Accessibility

This unit is typical of Pritchard's forward looking ingenuity in Design, Engineering and Construction. Designed to the customer's requirements for replacement of an existing crude unit and for processing six different types of crude oil at a nominal capacity of 22,500 bbls. day, this unit simultaneously produces eight different distillate fractions ranging from light gasoline to cylinder stock!

At the same time particular care was taken to design the unit for maximum accessibility to the heat exchanger equipment, thus facilitating handling and reducing "shut down" time and maintenance costs.

For the most modern advancements in petroleum processing, let Pritchard engineers develop your next project from drawing board to "on stream."

Our Single Responsibility Contract includes:

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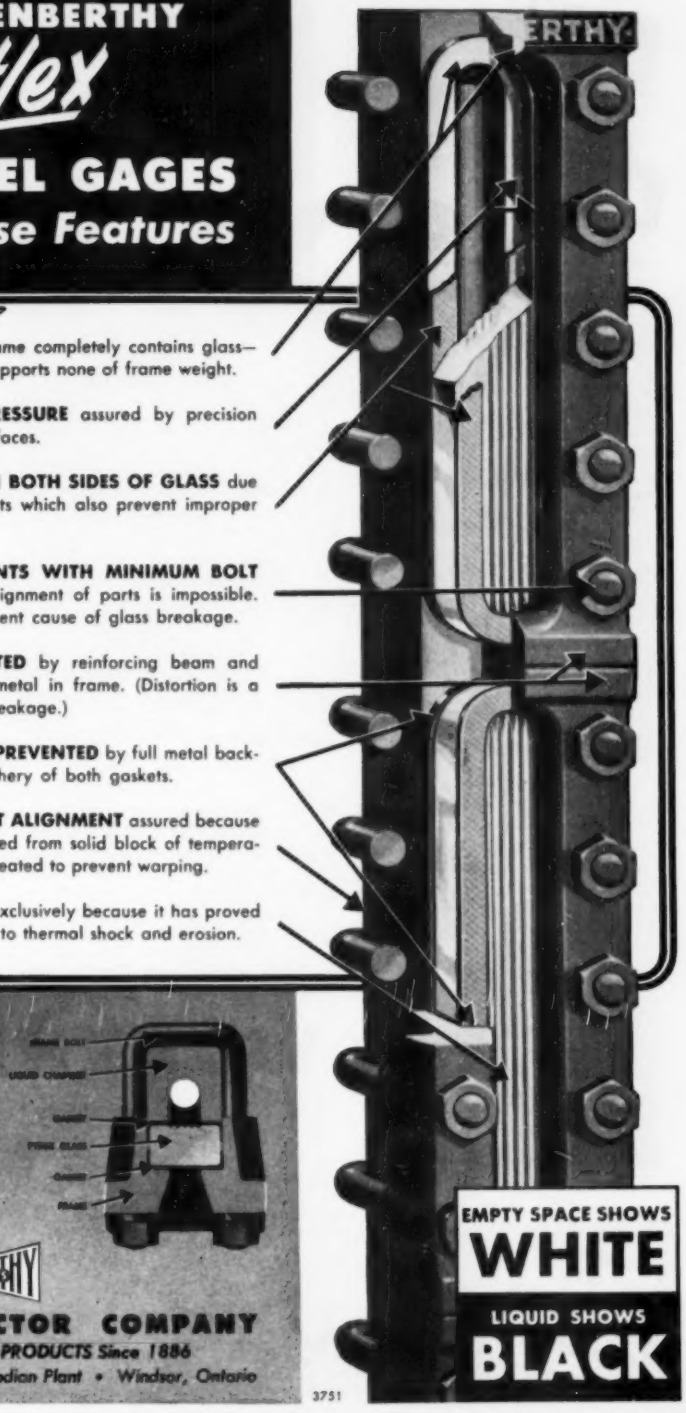
LIQUID LEVEL GAGES
Have All These Features

Drop Forged Steel

1. **PROTECTED GLASS.** Frame completely contains glass—no part exposed. Glass supports none of frame weight.
2. **UNIFORM GASKET PRESSURE** assured by precision finishing of retaining surfaces.
3. **EQUAL RESILIENCE ON BOTH SIDES OF GLASS** due to interchangeable gaskets which also prevent improper reassembly in the field.
4. **PERFECT GASKET JOINTS WITH MINIMUM BOLT TENSION** because misalignment of parts is impossible. This also eliminates frequent cause of glass breakage.
5. **DISTORTION PREVENTED** by reinforcing beam and scientific distribution of metal in frame. (Distortion is a serious cause of glass breakage.)
6. **GASKET BLOW-OUTS PREVENTED** by full metal backing of surface and periphery of both gaskets.
7. **RIGIDITY AND PERFECT ALIGNMENT** assured because liquid chamber is machined from solid block of temperature resistant steel heat treated to prevent warping.
8. **PYREX GLASS** is used exclusively because it has proved far superior in resistance to thermal shock and erosion.



Penberthy Reflex Gages make reading of liquid level easy and unmistakable; empty space always shows white—liquid always shows black. They are made in any length desired and from various materials to successfully withstand corrosion, contamination and high temperature conditions. Conform with API—ASME standards.

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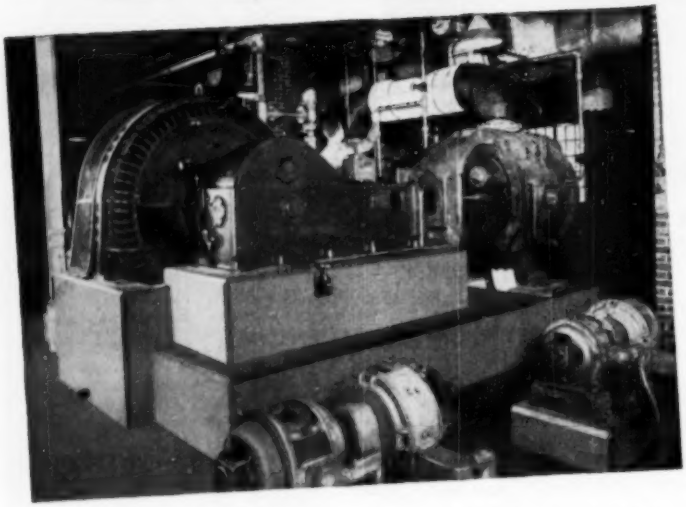

Worthington Vacuum Pumps Are Built to Meet the Petroleum Industry's Special Requirements

Worthington Horizontal Duplex Vacuum Pump —one of several Worthington units for solvent dewaxing service in the Tidewater Associated Oil Company's Refinery, Bayonne, N. J.

Back in the early days of the petroleum industry Worthington Vacuum Pumps were already setting the standard for economical, result-getting performance. Today, for solvent extraction, dewaxing and other vital processes, vacuum pumping by Worthington still sets the pace in refineries the world over.

That's because continued research into the petroleum industry's growing needs has developed Worthington Vacuum Pumps into highly specialized machines . . . precision-built for close clearance and high vacuum.

Every feature in these units is designed to increase efficiency and service life, at lowest possible operating cost. Top-quality materials give the necessary over-all ruggedness . . . simplified construction means easy accessibility . . . Feather*Valves with hardened alloy seats and guards are the quietest, "easiest breathers" ever made . . . conservative ratings assure abundant reserve power.

THE RIGHT UNIT FOR YOU

In the extremely wide range of Worthington Horizontal Dry Vacuum Pumps you're sure to find the unit most efficient for your own particular requirements. To aid your selection, Bulletin L-710-B1B contains a full listing of designs, sizes and drives, along with further proof that *there's more worth in Worthington*. Write to *Worthington Pump and Machinery Corporation, Compressor Division, Buffalo, N. Y.*

*Reg. U. S. Pat. Off.

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WORTHINGTON

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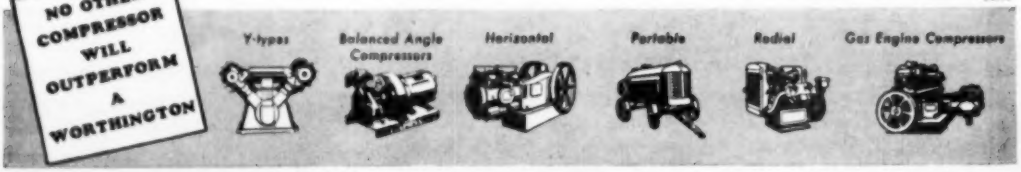
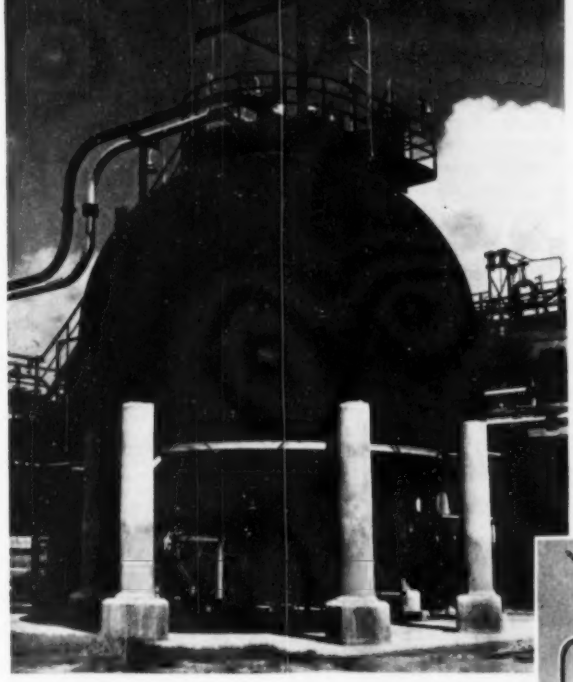


THIRD Electrosphere for desalting crude oil at Pan-American refinery

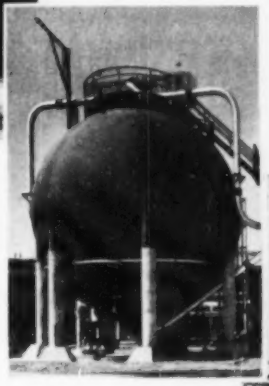


The 2,000-bbl. desalting Electrosphere shown at the left is the third such unit installed at the Pan-American Refining Company's Texas City refinery in four years.

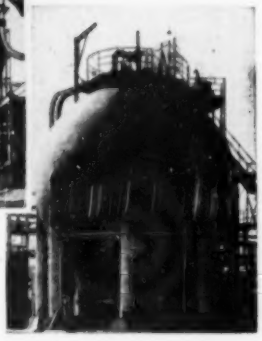
The Electrosphere is a combination of the familiar Hortonsphere and an electrical unit developed by the Petroleum Rectifying Company. In the desalting process, the crude is heated and emulsified with water. This mixture flows into the Electrosphere where the water and brine particles are coalesced and separated out by means of electrical attraction.

The desalting spheres at the Pan-Am refinery operate at a temperature of about 220°F and about 5.5 per cent of water by volume is added. Here's what the company says about the process—"The net effect (of desalting) is to increase continuity of operation and reduce maintenance."

We are happy that the Hortonsphere is part of such an efficient process. The Hortonsphere's inherent advantages—low cost per bbl. of capacity and small ground area for large storage volume—make it the ideal container for this application.



Left: Electrosphere Number 2 was installed at Cracking Unit No. 2 in 1948.



Right: Electrosphere Number 1 was installed at Cracking Unit No. 1 in 1946.

Other ways of using the Hortonsphere

Use as a *desalter* is just one special application of the Hortonsphere. In the oil industry, the Hortonsphere is generally associated with the storage and handling of highly volatile hydrocarbons like butane, butane-propane mixtures, and volatile refinery charging stocks. It has also been used for storing anhydrous ammonia, isoprene, and isobutylene.

Whenever you plan to desalt crude oil or store volatile hydrocarbons, you'll profit by using the efficient Hortonsphere. Write our nearest office for full details about standard capacities and working pressures.

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Chicago 4	2114 McCormick Building	Los Angeles 17	1526 General Petroleum Building	Seattle 1	1330 Henry Building
Cleveland 15	2215 Guildhall Building	New York 6	3310-165 Broadway Building	Tulsa 3	1620 Hunt Building

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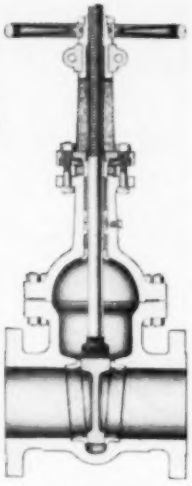

No. 33X, 300-Pound Steel Gate. For oil and oil vapor up to 1100° F. Exelloy to Exelloy seating. Sizes: 1½ to 24 inches.

STEEL VALVES FOR LONG SERVICE...EASY OPERATION

No matter how tough or how precise your service requirements . . . Crane Cast Steel Wedge Gates will meet them. Crane Quality construction assures highest resistance to pipe line strains, pressure variations, and extreme changes in temperature.

These valves are as easy to operate as they are to keep at peak efficiency. Closely-guided solid wedge disc seats accurately and smoothly; prevents drag and wear on seating surfaces. Side strain on stem is eliminated by Crane flexible T-head and disc-stem connection. Ball-type gland maintains even pressure on packing, avoids binding on stem.

Choose Crane Cast Steel Gates for dependable service. Regularly available in pressure classes up to 1500 pounds, for temperatures up to 1100° F. See your No. 49 Crane Catalog.

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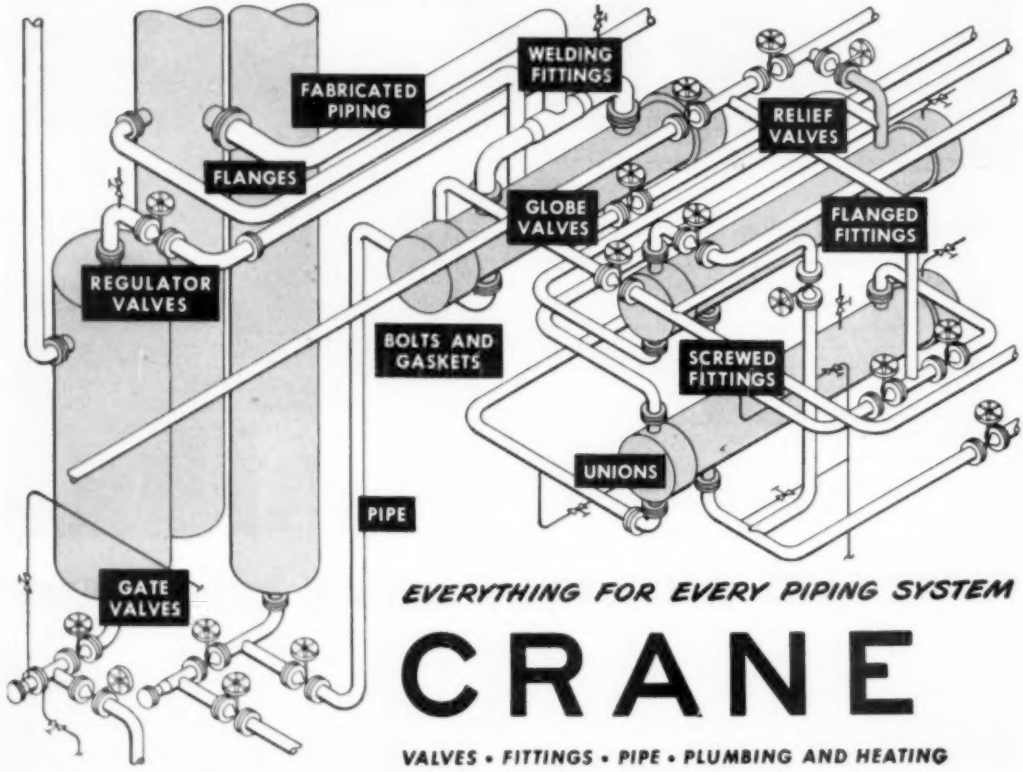

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CRANE

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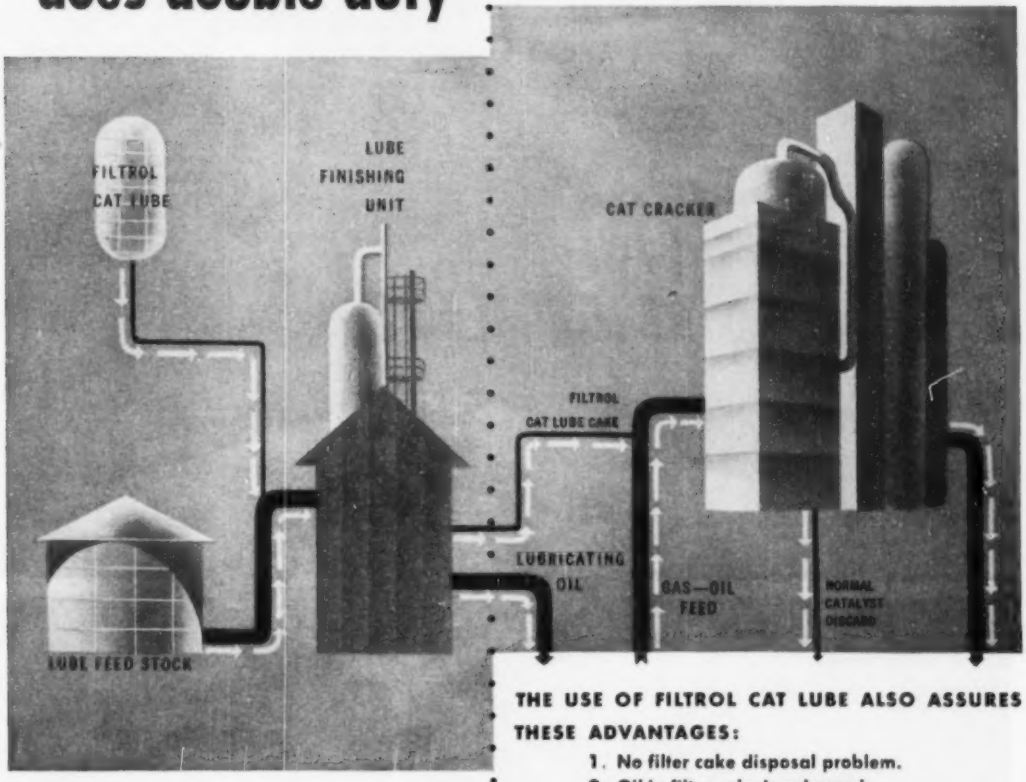
[*To obtain more data on advertised products see page* 882]

Filtrol* CAT LUBE does double duty

refines lubricating oil and then the spent adsorbent cake serves as a "fluid" cracking catalyst



THE USE OF FILTROL CAT LUBE ALSO ASSURES THESE ADVANTAGES:

1. **No filter cake disposal problem.**
2. **Oil in filter cake is salvaged.**
3. **Provides a constant supply of catalyst at practically no cost.**

An example of the successful use of Filtrol Cat Lube is the highly favorable experience of the Sinclair Refining Company which has been continuously using Filtrol Cat Lube for a year and a half with outstanding results in both lube processing and catalytic cracking.

Sinclair Refining Company was the first of many progressive refiners to take advantage of the economies made possible only through the use of "double duty" Filtrol Cat Lube.

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FILTROL CORPORATION

General Offices: 727 W. 7th Street, Los Angeles 17, California
Plants: Vernon, California and Jackson, Mississippi

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ADSORBENTS • CATALYSTS • DESICCANTS

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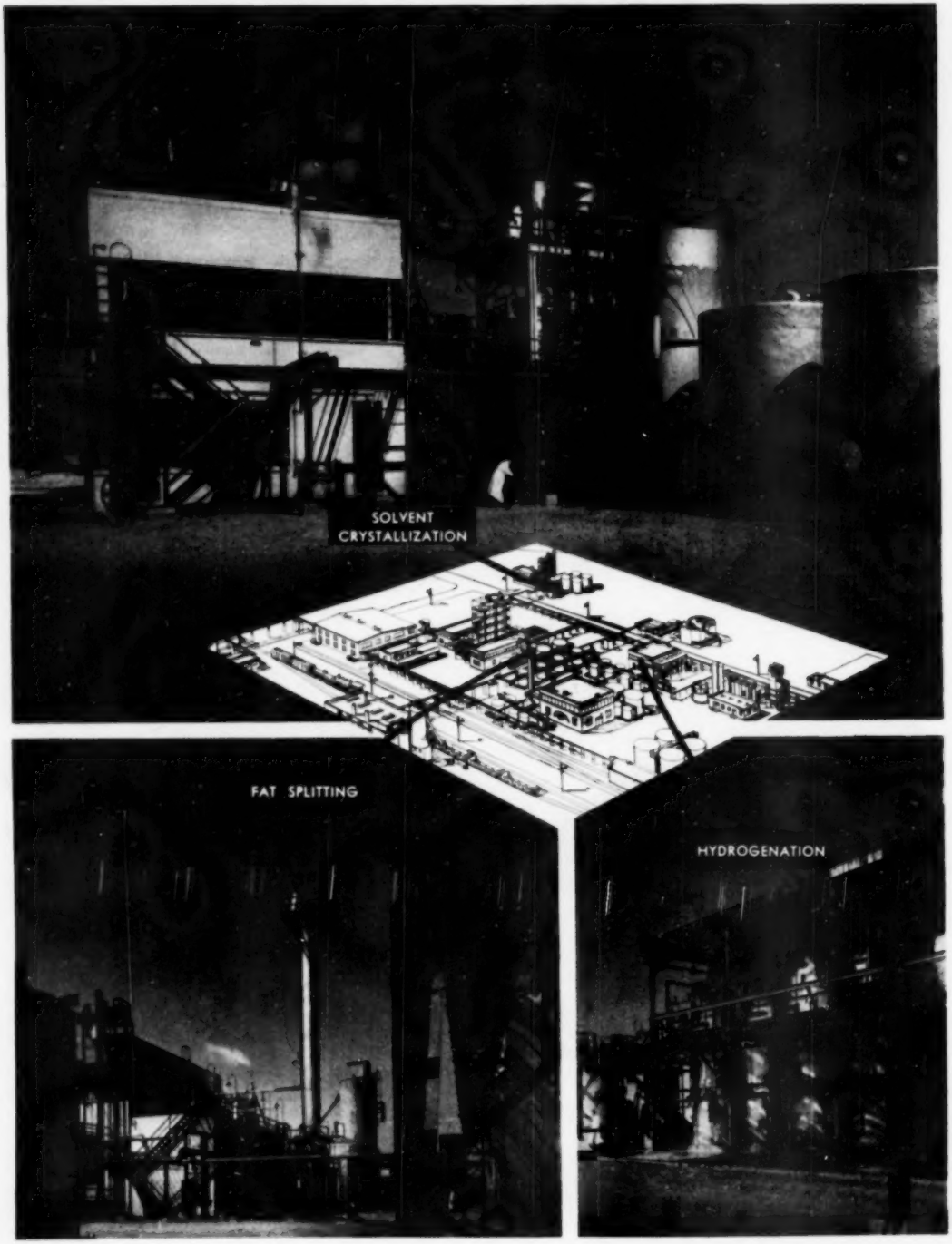
A New Process for Separating Fatty



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Acids by Fractional Crystallization

ANOTHER BADGER FIRST

The Fatty Oil Fractional Crystallization Process utilizing solvents as a means of separating fatty acids offers the industry an opportunity to make a wide variety of products of high purity and excellent yield at low operating cost.

A new Fatty Acid Fractional Crystallization unit, engineered and constructed by Badger, is now in successful operation at Armour's McCook, Illinois, plant. This unit permits separations with solvent over a wide range of operating temperatures. As a result, a variety of charge stocks can be processed and products of widely divergent characteristics manufactured.

This is a part of Armour's integrated plant for processing of animal and vegetable fats, designed on the basis of developments and extensive experience of Armour and Texaco, and engineered and constructed by Badger with the exception of three specialized units furnished by others. Among the Badger-built units, as well as the crystallization unit, are installations for fat splitting, hydrogenation, refining and bleaching, product finishing and a boiler house, waste recovery system, tankage, warehousing and shipping, and all auxiliary facilities.

The Fatty Oil Fractional Crystallization unit is operated under license from the Texaco Development Corporation. Into this unit Badger has built the "know-how" of both Texaco and Armour. This is another example of Badger's unique ability to convert basic design of a new development into a successful commercial plant.

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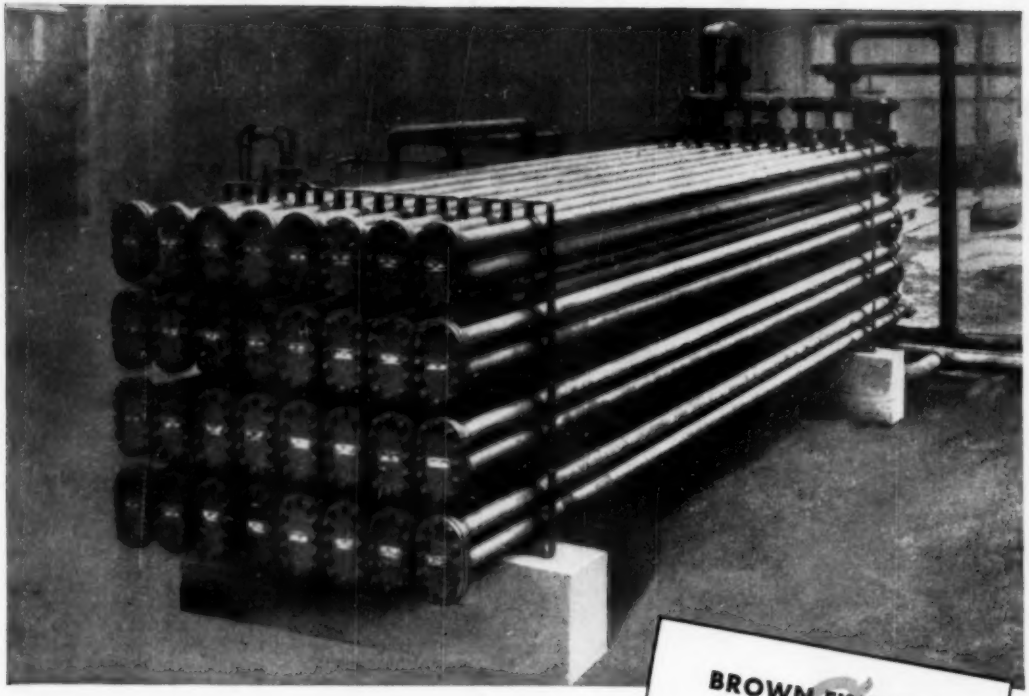

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Brown Fintube Sectional Heat Exchangers

are easily adaptable to changes in duty

● You'll get almost unlimited flexibility to meet changes in duties, plant re-arrangements, etc., with Brown Fintube Sectional Heat Exchangers. The banks can be changed over *easily* and *quickly*, to operate *efficiently* on almost any *new* and *different* duty. You simply add a few sections, remove a few sections, or change the series-parallel manifolding.

For the utmost in efficiency and economy use Brown's proven, welded fintube heat exchangers throughout your plant. Estimates and quotations furnished promptly. *Write for Bulletin No. 481.*

BROWN FINTUBE'S *advantages*

EXTREME FLEXIBILITY
Easily Adapted to Changes in Duty
NO OBSOLESCENCE
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PETROLEUM PROCESSING
AUGUST 1950

New Refining Equipment Needed For Volume Avgas Manufacture

TO make the quantities of 115/145 grade aviation gasoline that would likely be required in another major war would "certainly involve great new investments in special refining equipment", Bruce K. Brown, president of Pan-Am Southern Corp. and chairman of the Military Petroleum Advisory Board, told the Board at Houston July 13.

"On the other hand", he said, "the certain shifting toward a higher quality of avgas (with an accompanying lower potential producing capacity at our refineries) is only a minor problem compared to the jet fuel supply problem.

"Because of the rapid technological development of jet and turboprop planes, each week brings with it a lessened potential requirement for avgas for internal combustion engines and a larger potential requirement of fuels for jet planes."

At the peak of World War II, Mr. Brown stated, we got along very comfortably with about 600,000 b/d of 100-octane gasoline and about 200,000 b/d of other grades of avgas. Grade 115/145 was used very little and only in the later stages of the war. (100-octane and some other grades of avgas were made by blending alkylate with a base gasoline stock made in catalytic cracking units. The higher octane aviation gasolines used today are almost entirely alkylates. The best available published information today is that requirements the rest of this year will amount to 70,000 b/d for 100/130 and 115/145 grades of avgas.)

Some Needs Won't Change

Mr. Brown said it could be assumed that, in the event of another major war in the next few years, the maximum requirements for the ground forces and the sea forces of the U. S. and its allies would not differ markedly, either in specifications or in quantity, from the military requirements as they existed at the peak of World War II.

"This is for the reason", he said, "that in all probability the number of persons available for the military services will not be much greater, and the petroleum consumption by fighting men on the sea or on the ground will probably be of the same order of magnitude as before.

"However, the air is a different story. While the number of men in the air forces may not be much different than before, the planes themselves will be larger and heavier and will use larger volumes of petroleum products."

In estimating essential civilian requirements during a major war, Mr. Brown said account must be taken of the great increase in the automobile population in the U. S. and the accompanying decentralization of human population. Account must also be taken of the increase in the use of oil for heating and Diesel fuels on the railroads instead of coal or No. 6 fuel oil.

In appraising petroleum national security in the light of probability of another major war, we have to deal with four primary considerations, Mr. Brown told the Military Petroleum Advisory Board, and to take into account four fundamental variations that may occur in them. He outlined the four considerations as follows in his talk:

The Four Considerations

"The first consideration is, of course, the availability of crude oil and equivalent products in quantities sufficient to win a war and to sustain the civilian population.

"The second consideration is that of refining capacity. Is there enough refining capacity available to refine the quantities of crude and other products that are assumed to be available for refining?

"The third consideration is whether sufficient transportation is available to move the crude to the refiners and to move the products from the refineries.

"The fourth consideration is the 'requirements;' that is, the quantities of petroleum products that will be required to sustain the military and civilian effort. Naturally in wartime the requirements of the armed forces rise far above what they are in peacetime. Civilian requirements would tend to rise too, at least in the early stages of stepped-up civilian activity, and until such time as so many persons were inducted into the armed forces that a part of the civilian demand was translated into military demand.

"The general question of the feasibility of reducing civilian consumption in order to make more material available for military consumption is, of course, the problem of rationing and it fits in as an integral part of the general consideration of requirements.

"In studying the four fundamental considerations (that is, availability of crude, availability of refining capacity, availability of transportation and the requirements themselves) we have to take into account four fundamental variations that may occur in these considerations on account of war.

The Four Variations

"The first variation is the possibility that some of the geographical areas upon which we rely may become unavailable to us. One example of such a variation would be the assumption that our enemies might capture Middle Eastern oil installations or bar our tankships from the Caribbean trade routes. Another extreme case would be the invasion of say, California or Texas. Also, and perhaps more practically, we have to consider as a part of this variation the possibility that some of our domestic petroleum facilities will be put out of action by sabotage or bombing from the air.

"The second variation which may be imposed by war is in the form of new disabilities that may arise in the field of transportation. Of course, the blockading of tanker movements from South America (which I have already referred to in variation No. 1) would constitute an impairment of transportation. However, as we learned during World War II, there are many other impairments of petroleum transportation that may occur in time of war and that would not result from any direct enemy action but rather from a general dislocation of petroleum supply.

"A third variation that may occur in wartime would be a restriction in the quantity of steel and other materials (and of manpower) that may be available to sustain petroleum industry operations.

"The fourth major variation that may occur is in the field of storage of petroleum and its products. Generally speaking wartime conditions will require more storage than peacetime conditions. The imposition of wartime conditions may result in a situation in which storage at a given point or group of points may become inadequate even though it was adequate for peacetime operation."

Personnel Problems

Refiners should classify their technologists and skilled workers enrolled in the Reserves according to the essential nature of their work. Read Editorial, p. 898.

Jet Fuels—What Kind, at What Cost?

From a Report by A. R. OGSTON
Aviation Dept., Esso Export Corp.

Growing use within the next few years of turboprop or turbojet engines in commercial transport planes raises the question as to the most practical type of fuel for such aircraft. Kerosine of the same grade as is used for lighting and heating porposes has desirable properties for jet fuel, unless the freezing point requirements are made too severe, and economies in distribution can be secured since this product is already being widely handled. It is believed refiners without difficulty can provide the volumes required during at least the introductory period of gas turbine transports at substantial differentials under the price of aviation gasoline.

THE development of the aviation gas turbine during the past decade represents probably the greatest single contribution in the field of aeronautics since the combined work of the early pioneers which culminated in the first powered flight by the Wright brothers.

The remarkable rate of progress in the initial development of the turbojet engine resulted in over-optimism as to the time required for the new type of power plant to completely replace the piston engine. Five years ago the belief was widely held that the reciprocating engine had only a few years of active life remaining. It is now apparent, however, that this type of aircraft power plant will continue in service for 10 years and perhaps longer.

It is of interest to compare this transition from reciprocating to turbine power with the introduction more than 50 years ago of the steam turbine for ship propulsion. The initial enthusiasm for the vibration-free steam turbine, as demonstrated in the first steam turbine-powered vessel Turbinia, led to a general belief that the steam reciprocating engine would be completely superseded by the turbine in a few years. In reality it took nearly 25 years for the steam turbine to be generally adopted as the superior type of ship-propulsion plant. Even today some ships are still being built with steam reciprocating engines.

Although the major airlines are now ordering for delivery a year hence new airplanes powered with reciprocating engines, it seems reasonably certain that, within the next few years, many airlines will be placing orders for transport planes equipped with either turboprop or turbojet engines. The British Overseas Airways and the British European Airways are, in fact, already committed to taking delivery of a sizeable number of Vickers Viscount turboprop and de Havilland Comet turbojet transports. Two of the latter type have also been ordered by Canadian Pacific Airlines. The Vickers Viscount and also the Avro C-102 jetliner have been or are on the point of being ordered by Australian operators, while orders for turbine-powered aircraft by other airlines are reported imminent. It is, therefore, by no means premature to consider the type of fuel to be used by these new aircraft.

What Kind of Fuel

In considering the fuel question, turbine-powered aircraft should be divided into separate categories, 1—military types and 2—commercial transport types. So far as military jet or turbo-jet aircraft are concerned, supply and availability will probably be the predominant factors in deciding the type of fuel to be used, in view of the enormous quantities likely to be required in the event of war. It has been estimated that such quantities could amount to 20 or 25% of the total available crude oil production. On the other hand, it seems reasonable to assume that the type of fuel to be adopted for passenger-carrying turboprop or jet airliners should be that most suitable from the standpoint of safety and efficiency, giving due weight to the problem of distribution and cost.

Consumption of fuel by commercial airlines at present is less than 1% of total crude production. Even with considerable expansion during the next 20 years or so by airlines throughout the world, it seems unlikely that the fuel consumed during this period could exceed 3 or 4% of total crude production.

Even allowing for the higher consumption of jet aircraft, it will surely be many years before the daily fuel consumption of turbine-powered passenger tranport planes throughout the world, can attain a volume equivalent to 3 or 4% of crude oil production. Also, a progressive increase in world crude production will almost certainly take place during the next 20 years.

There appears, therefore, no justification for the question of refinery availability becoming a major factor in deciding the type of fuel to be supplied to airlines for their turbine-powered aircraft. The choice of the fuel should then be governed by the answer to the question: Which fuel best combines the requirements which contribute to maximum safety and efficiency?

The present type of reciprocating-powered transport aircraft inherited a type of fuel originally provided for automobiles and subsequently developed for military aircraft. Had it been practicable to exercise any choice as to the type of fuel used by passenger transport aircraft, it is doubtful if the selection of a highly volatile fuel such as gasoline would have been approved.

A gas turbine can be made to operate on a wide variety of fuels, ranging from low grade gasoline to heavy fuel oil. However, the exacting duty of airplane propulsion calls for a fuel which will ensure maximum combustion efficiency, best possible economy in fuel consumption, freedom from corrosive or deposit-forming characteristics (which would shorten periods between engine overhaul) and which will in addition reduce fire hazards to a minimum.

It is probably easiest to obtain the best combustion efficiency with gasoline. However, there is little doubt that a fuel of the general characteristics of kerosine comes closest to satisfying all the previously mentioned requirements. With suitable nozzle design and adequate fuel pump pressure, combustion efficiency equal to that obtained with a more volatile, fuel such as gasoline, can be realized. As regards economy, in terms of air-miles per gallon, a kerosine-type fuel should be as much as 10% superior to gasoline. This better economy is due to the higher Btu content and does not take into account the evaporation losses liable to be encountered with gasoline when used in jet transports, with their rapid rate of climb and need to operate at great heights.

Question of Safety

On the subject of relative fire hazards, there can be no question that the use of a fuel of similar boiling range and flash point to kerosine will provide a higher standard of

safety than is possible with gasoline, or with wide-range distillate fuels such as are covered by U. S. Specification MIL-F-5624, Grade JP-3 (formerly AN-F-58a). See Table 1.

It will be recalled that some years ago the Standard Oil Development Co. brought out a high-octane, low-volatility "safety" fuel for piston engines. This work arose from the conviction that high-flash fuel would contribute to greater safety in airline operation. Experimental quantities of such a fuel with a flash point above 100° F. were manufactured and the project created enthusiastic interest among airline operators. Unfortunately, certain practical difficulties encountered in the use of such a fuel in existing types of reciprocating engines prevented its adoption, while other adverse factors were the rather high cost and limited availability.

Severe fires have occurred following the crash of a jet fighter plane using kerosine, and this has been used as an argument to discount the claims for the greater safety of kerosine. However, it was found that, in such crashes, the aircraft hit the ground at high speed, causing complete disintegration of the structure and bursting of fuel tanks, with the result that highly heated engine parts were doused in kerosine. In such circumstances fire is inevitable, but it is equally inevitable that the occupants of the aircraft will have been killed by the impact with the ground.

On the other hand, many instances are on record of minor crashes of jet fighters where fuel tanks have been damaged. Although the surrounding area was saturated with kerosine there was no fire and the pilot survived. In such instances, had the fuel been gasoline, the chances of sudden disastrous conflagration occurring are many times greater.

Another question of the claim for the increased safety of kerosine turbo fuel is the contention that, at high altitude with fuel well above the ambient temperature, (Fig. 1) an explosive vapor forms in the vapor space on the airplane's tanks, whereas under similar conditions with gasoline the vapor will be too rich to be within the explosive range.

While this contention is correct, there is absence of proof that with a commercial aircraft flying at high altitude there would be any source of ignition in the interior of the fuel tanks to ignite the vapor. Static discharges encountered in flight are, as far as is known, confined to the exterior surfaces of the aircraft. In any case, when a conventional-type aircraft using gasoline makes a descent from high altitude this must frequently result in an explosive vapor in the tank for a period. However, there are no recorded instances of fuel-tank explosions arising from this cause except those resulting from enemy action during the war.

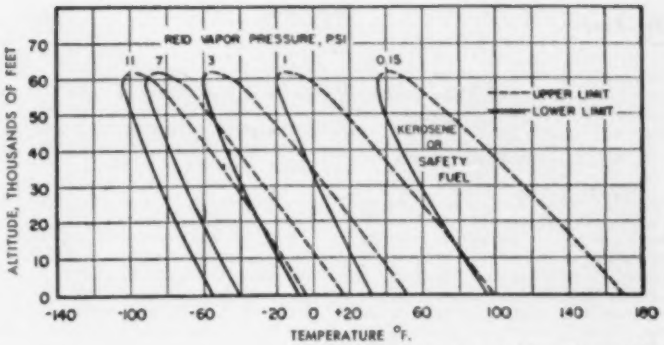


Chart courtesy Co-ordinating Research Council, Inc.

FIG. 1—Explosive limits as affected by altitude and fuel temperature (Normal vents and without blanketing)

If some safeguard against the theoretical hazard of fuel-tank vapor is considered necessary, a simple expedient would be to provide scavenging of the vapor space in the tanks to prevent the accumulation of kerosine vapors. The scavenge line could be directed into the intake system of the turbine. By suitable design it should not prove difficult to eliminate the possibility of liquid fuel entering the vapor scavenging line. Such a method could not be used in the case of gasoline or other volatile fuel. Evaporation losses would be prohibitive and the vapor, from being too rich and therefore safe, would merely be brought into the explosive range.

Freezing Point

The relatively high freezing point of kerosine is raised in some quarters as an objection to its use in turbine-powered aircraft. Generally speaking, there is little problem in manufacturing kerosine to meet a −40° C (−40° F.) maximum freezing point. This is the temperature requirement in the current British aviation turbine fuel Specification D. Eng. R. D. 2482. The U. S. Specification MIL-F-5616, Grade JP-1 (formerly AN-F-32a) however, requires a freezing point of −60° C (−76° F.). See Table 1.

Both these fuels are of the kerosine type. While the −60° C. freezing point may be necessary to satisfy military requirements (involving possible operation in extremely cold climates and at exceedingly high altitude), it is considered that a less stringent requirement should be acceptable for commercial aircraft. Commercial airliners are unlikely to encounter ground fuel temperatures lower than −30° C. (−22° F.) and that would be in comparatively few areas. In flight, especially at the high altitudes at which turbine aircraft will operate, fuel temperatures may

TABLE 1—Aviation Gas Turbine Fuel Specifications of the U.S. Armed Services

Property	JP-1 MIL-F-5616	JP-2 AN-F-34	JP-3 MIL-F-5624
Aromatics by ASTM ES-45, Vol. % max.	20	20	25
Bromine No., cg/gr., max.	3.0	3.0	30.0
Sulfur, Wt. % max.	0.20	0.20	0.5
Spec. Grav., 60/60 max.	0.850	0.850	....
API Grav. 60/60 min.	35	35	45-63
Freezing Point, °F., max.	—76	—76	—76
Color, m/n, Saybolt	+12	+12	....
Water Tolerance	Immisc.	Immisc.	Immisc.
Mercaptan Content, % max.	....	....	0.005
RVP, lb/sq. in.	....	2.0 max.	5-7
Flash (Tag.cc.), °F. min.	110	....	....
ASTM Distillation, % Evap.:			
IBP, °F. min.	....	150	....
10%, °F. min.	410	....	....
20%, °F. max.	....	....	....
90% °F.	490 max.	....	400 min.
FBP °F. max.	572	500	600
Dist. Loss, % max.	1.5	1.5	1.5
Res. after Dist., % max.	1.5	1.5	1.5
Res. by Air Jet (a) max.	5.0	5.0	10.0
Accel. Gum, mg/100 ml. max.	8.0 (16 hrs.)	8.0 (7 hrs.)	20.0
Cu. Strip Corrosion (212° F. 3 hrs)	None	None	None
Ubbelohde Viscosity:			
Centistokes at —40° F. max.	10	10	0
Centistokes at 0° F. max.	....	....	....
Centistokes at 100° F. min.	....	0.95	....
Heating Value, Net Btu./lb., min.	....	....	18,400
Inhibitor			(b)

(a) By the ASTM D-381-46 procedure.
(b) Inhibitors allowed not to exceed 1 lb./5000 gals: UOP 5; Dupont 22; Shell 2,4 M6B; Shell Ionol.

frequently descend to −40° C., and even lower on flights of long duration unless some means is provided for heating the fuel.

Specification Requirements

The availability and cost of kerosine-type turbo fuel will be appreciably affected by the specification requirements of the airline operator. Certainly, in the early stage of the introduction of turbine transports to international airline routes, economies in fuel costs will be realized and supply problems considerably eased if the fuel used should be the same grade of kerosine already widely distributed by major oil companies to consumers for lighting and heating purposes.

It so happens that kerosine having good burning characteristics in oil lamps and heaters is also an excellent fuel for gas turbines. The original British Specification D. Eng. R. D. 2482 for aviation turbine fuel was based on the grade of kerosine generally available in England for domestic usage. Fuel to this specification has since been used for all the jet aircraft operated by the Royal Air Force and for the fighter planes equipped with jet engines of British design operated by the French, Belgian, Swedish and other air forces in Europe.

It should be made clear that an efficient gas-turbine fuel does not necessarily require all the characteristics of a kerosine sold for lighting and heating purposes. Use of this product by the airlines is advocated in the initial stages mainly to simplify the supply and distribution problem and thereby insure minimum fuel costs. When the airline demand for turbo fuel has grown to large proportions, it may then prove desirable to establish a separate grade, the principal characteristics of which would be controlled by specifying limits for distillation range, flash point, freezing point and aromatic, sulfur and gum contents.

As already pointed out, a freezing point requirement of −40° C. (−40° F.) for kerosine can be met without great difficulty but if a lower temperature is to be specified, availability will be restricted and product cost increased, due to the need to limit production to specially selected low cold test crudes or, alternately, to undertake special processing. It is therefore submitted that here is an instance where the aircraft designer must come to the aid of the fuel manufacturer and devise means for preventing fuel in the aircraft tanks from freezing.

With so much surplus heat available, this should not be a particularly difficult problem, especially in view of what has already been accomplished in the way of thermal de-icing of wings and propellers, carbon heating and so on. One possible means in the case of turboprop installations might be to submerge or "bury" the engine oil coolers in the fuel tanks thereby at the same time saving drag. In the case of straight-jet engines, it is doubtful if there would be sufficient heat rejection to the oil to provide enough heat transfer to the fuel.

Table 2 lists the main requirements tentatively proposed as an interim specification to cover aviation turbo fuel for use by commercial operators. It follows the lines of the British D. Eng. R. D. 2482 Specification which, as already mentioned, has ensured the provision of a fuel that has given completely satisfactory results in military types of jet aircraft.

Cost

A question of considerable interest to airline operators contemplating the future purchase of turbine-powered aircraft is the probable relative cost of turbo fuel and aviation gasoline. It is probable that, per gallon, aviation turbo fuel will cost less.

At present the major volume of kerosine produced is used for lighting and heating purposes, particularly in under-developed areas to which electrification and gas distribution has not yet been extended. An appreciable volume of kerosine is used as farm tractor fuel. It is reasonable to assume that the consumption of kerosine for these purposes (with perhaps the exception of farm tractors) will tend to diminish in the future, while the demand for kerosine-type aviation turbo fuel will grow. If these two factors balance each other and if a substantial demand for some new purpose does not develop, the price of the grade of kerosine under discussion should tend to remain around present levels.

Kerosine is currently quoted in tanker cargoes at the U. S. Gulf at between 8.5 and 9c/gal. This compares with about 16c/gal. for Grade 100/130 aviation gasoline and 17.25c for Grade 115/145. Due to the ever increasing demand for middle distillates, a shrinkage in these differentials should be expected and a very substantial narrowing is entirely possible. However, their elimination is not indicated for the foreseeable future.

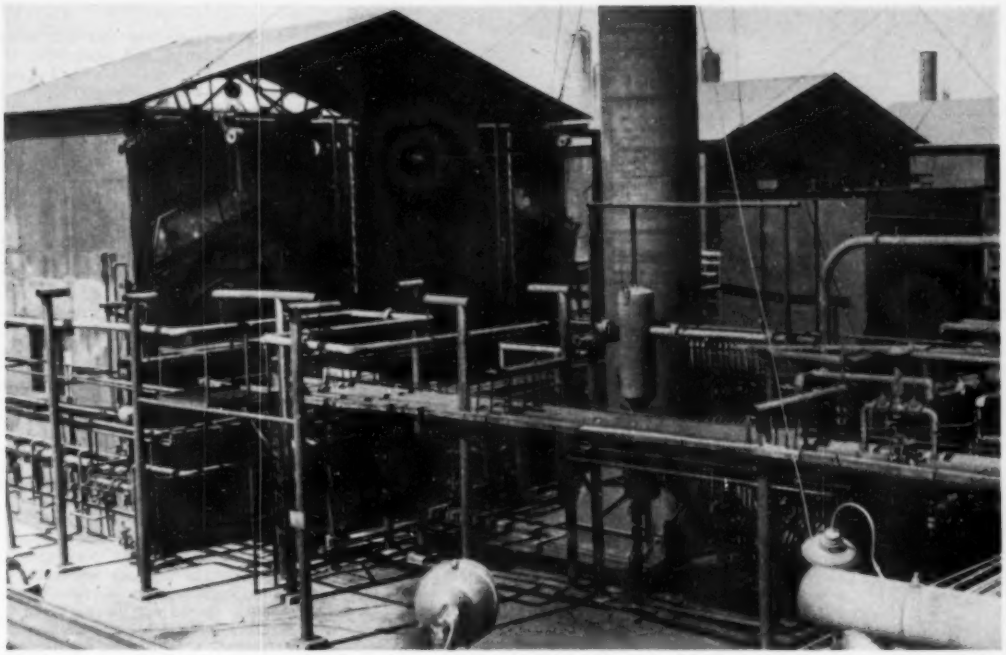
An appreciable proportion of the price of aviation fuel delivered into the airplane's tanks is the cost of shipment from the refinery to the airport concerned. A journey of thousands of miles and various means of transportation of the product may be involved. Depending on these and other factors, the differential over the U. S. Gulf cost may vary from as low as 5c/gal. to as high as 50c in the case of relatively inaccessible airports in some South American countries. The costs for distributing aviation gasoline and turbo fuel should be about the same. However, in the early stages, the cost of making turbo fuel available at airports will tend to be higher than for gasoline, due to the cost of providing new facilities and airport equipment.

For the immediate future and after due allowance for the above factors, it should be possible to supply kerosine-type turbo fuel of the proposed quality at major international airports at a cost which, for a regular off-take, would be 4 or 5c/gal. below the present airport cost of Grade 100/130 gasoline. In the event the growth in the overall demand for the kerosine-type turbo fuel is greater than now anticipated, it would be necessary for refiners to increase their production by diverting into the kerosine stream certain fractions which would normally be included in motor gasoline, diesel fuel or heating oil.

At present, the production of kerosine represents about 6% of the total crude oil processed. This yield could be increased to around 10% by the above-mentioned procedure and by producing as much kerosine-type turbo fuel as possible from crudes not normally processed for the production of kerosine for heating and lighting purposes. If circumstances warranted, still further supplies could be obtained by modifying cracking processes to give increased yields of product within the kerosine boiling range at the expense of gasoline production. The effect of such measures to boost production would almost certainly increase the cost of the turbo fuel, although to what extent would depend on market factors not now predictable.

TABLE 2—Proposed Specification of Aviation Turbo Fuel for Turbine Transports

Gravity: Not to be limited but to be determined and noted.
Flash Point (Closed): Not lower than 38° C. (100.4° F.).
Freezing Point: Not higher than —40° C. (—40° F.).
Viscosity (Kinematic): Not over 6 centistokes at —18° C. (—0.4° F.).
Sulfur: Not over 0.2% by weight.
Corrosion: No evidence of corrosion and not more than slight discoloration of the copper strip.
Residue: Not over 10 mg. per 100 ml. of fuel after evaporation by the air jet method.
Accelerated Gum Content: Not to exceed 20 mg. per 100 ml. of fuel.
Water Tolerance: Substantially immiscible with water.
Aromatic Content: Not over 20% by volume.
Distillation: Minimum 10% evaporated at 200° C. (392° F.). Final boiling point 300° C. (572° F.) max. Distillation loss 1½% max.
Heat of Combustion: 18,300 Btu. minimum.



LONGER LIFE OF TUBES in furnaces is secured by Phillips Petroleum Co. by using special tube-life charts. This particular battery of three gas-fired heaters, installed at Phillips' Borger, Texas, plant for cracking propane and ethane, was used by company engineers to develop the method of preparing the charts

TUBE-LIFE CHARTS

Used to Secure Optimum Service Life Of Furnace Tubes Before Replacement

By D. P. THORNTON, Jr.
Southwestern Editor

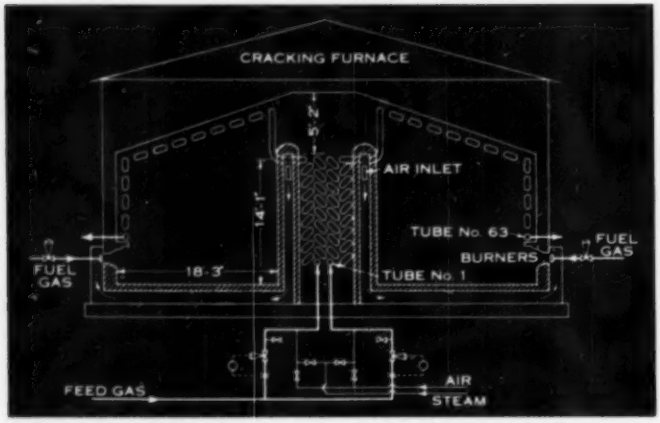
ONE of the principal maintenance items associated with fired heaters handling petroleum hydrocarbons is the replacement of tubes and associated return bends on some systematic basis, through which replacement is scheduled at an "optimum time." Obviously the replacement date selected should fall between a maximum, dictated by the desire to obtain the greatest utilization of tube metal (tube life), and a minimum, set by the need to avoid failure in service with the added possibility of a serious fire and certainty of interrupted onstream time.

In the determination of that optimum time, as Hamlet so aptly put it, "comes the rub." Phillips Petroleum Co. has worked out a method of preparing "tube-life charts" in connection with its operation of furnaces cracking propane-ethane mixtures to produce ethylene. The method is particularly applicable for exceedingly severe furnace duties, where tube replacement frequencies are high. While the procedure may be unnecessarily complicated for less severe services, it may be modified as desired for other applications.

In the early stages of the operation of the furnaces, excessive maintenance costs were involved, due to erosion of return bends and tube metal. Furnaces were being shut down on the average of 6 to 7 times per month to patch or replace tubes and bends in addition to the regularly-scheduled shutdowns for carbon burnouts. Various tube alloys were tried and likewise various alloys and return bend designs were experimented with. For proper evaluation of tube materials, detailed records were kept by a plant engineer, which were the nucleus of the tube-life charts. A description of much of this work, to which the reader is referred for further details, was published in PETROLEUM PROCESSING, April, 1950, pages 387-391.

The tube-life charts as developed by Phillips engineers, can be made to yield a variety of useful information. For instance, it is possible to tell at a glance the exact date when a furnace was off-stream for tube repair, and how many tubes were replaced at that time. A reasonably accurate estimate can be made of when to expect another shutdown for tube replacement, and what tubes will be involved. From this information preparations can be made in advance for the anticipated work.

It should be emphasized, however, that the tube-life charts are in no sense a substitute for thorough inspection. The tubes should be inspected as if the charts did not exist. Inspection findings may properly be noted on the chart for future use.



SCHEMATIC DIAGRAM of arrangement of tubes in cracking furnaces shown on p. 827. Each furnace has two separately-fired combustion chambers housing the radiant coils, and a common convection section housing the two convection coils

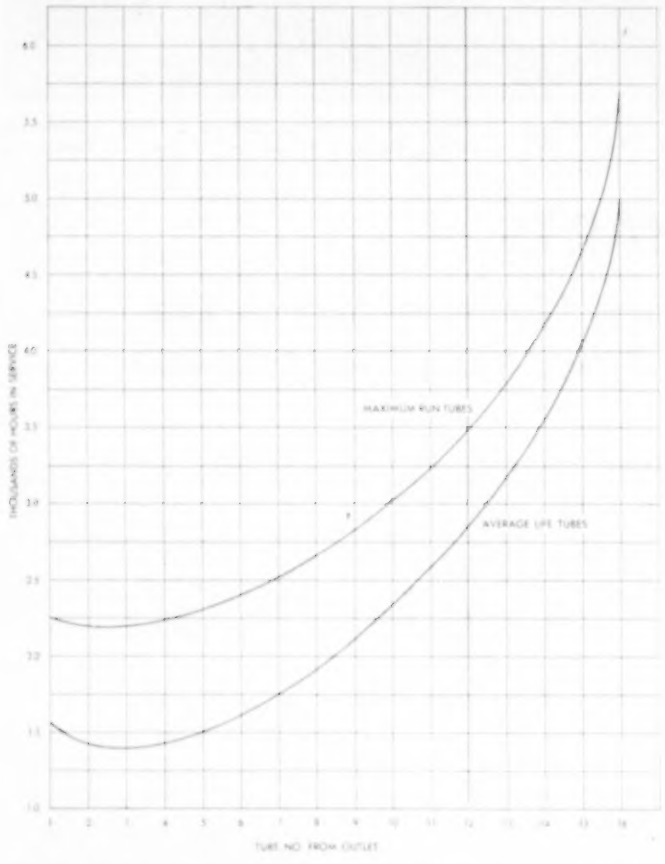


FIG. 1—Plot of service life of furnace tubes, showing life of maximum run tubes and the average life for each tube position

In general, before tube-life charts can be prepared and used with any assurance of reliable results, it is necessary to have a considerable backlog of operating experience with the particular furnace and reasonably constant operating conditions.

Average Tube Life

The mainstay of the Phillips chart is a superimposed curve representing the average length of time a tube may be expected to be serviceable in a given position. In general, only the radiant section of the furnace need be considered except under special conditions, since normal convection section duty is seldom as rigorous. The only way an average life expectancy curve can be drawn is to have enough accurate data on the performance of numerous tubes.

Data for the preparation of tube-life charts may be secured in various ways. The principal requirement is accuracy and not "guesstimates." Selection of the data to be shown should be by a plant engineer who is specifically assigned to that duty and informed on the purpose and value of the work. There is no reason why the data should not be gathered by operators, but neither preparation nor interpretation of the charts should be entrusted to operators or the plant maintenance department.

The most convenient source of information will be operational data sheets which most plants keep on either an entire unit or its important components. These differ widely in detail, but in general show temperatures, pressures and flows at various points, characteristics of the charge and product, hours on-stream and the like for set periods of time.

At the Phillips ethylene unit, a separate data sheet was kept for each furnace. Operators recorded hourly observations of charge stock characteristics, flow rates, temperatures, and pressures on various tubes and return bends, firebox temperature and hours on-stream. The process engineer in charge of the unit kept records of individual tube positions on separate cards. An individual card showed the service history of every tube which was installed in that position, including date of installation and removal, its size, whether new or salvaged, and the analysis of the alloy.

Another record system was kept on every tube which was used in any furnace, from the time of purchase until it was scrapped. It included data on every position it might have occupied in the furnace and any repairs which it might have received.

For instance, the record on a new tube might show it had been placed in the coil outlet for 500 hours, removed because of a hot-spot formation, straightened and stub-ended, and replaced in No. 32 position at the beginning of the radiant section, from

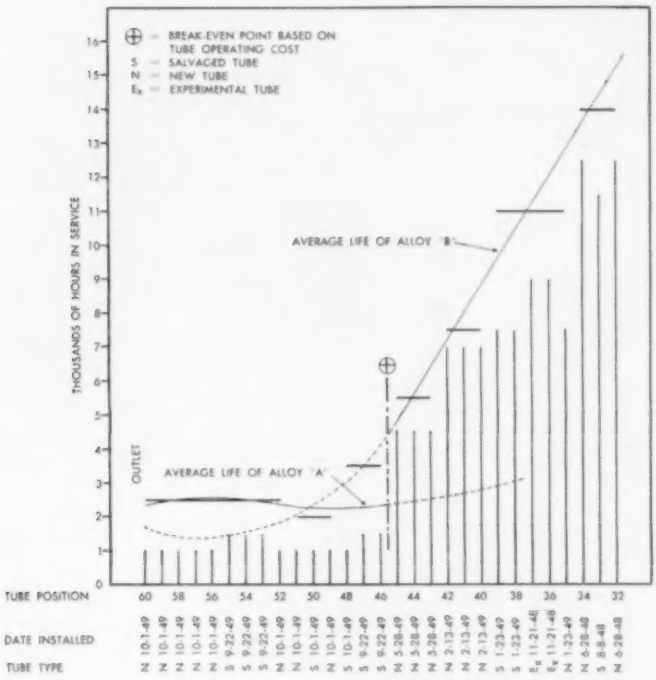


FIG. 2—Typical example of a tube life chart, showing average tube life per tube position, service of tubes in use and anticipated replacement time. Tubes of two general alloy types are in use plus two "experimental tubes" of different alloy

whence it was removed after 7000 more hours and ultimately utilized for stub-ending other prematurely-failed tubes.

Any convenient identification system may be used to denote tube position or to identify an individual tube. On the latter, particularly, experience has indicated it is best to rely on some arbitrary marking, such as a paint-stick, rather than to record the manufacturers heat number. This is because the heat number usually is stamped on one end of the tube and might be lost should the tube be shortened for some reason.

Tube Life Charts

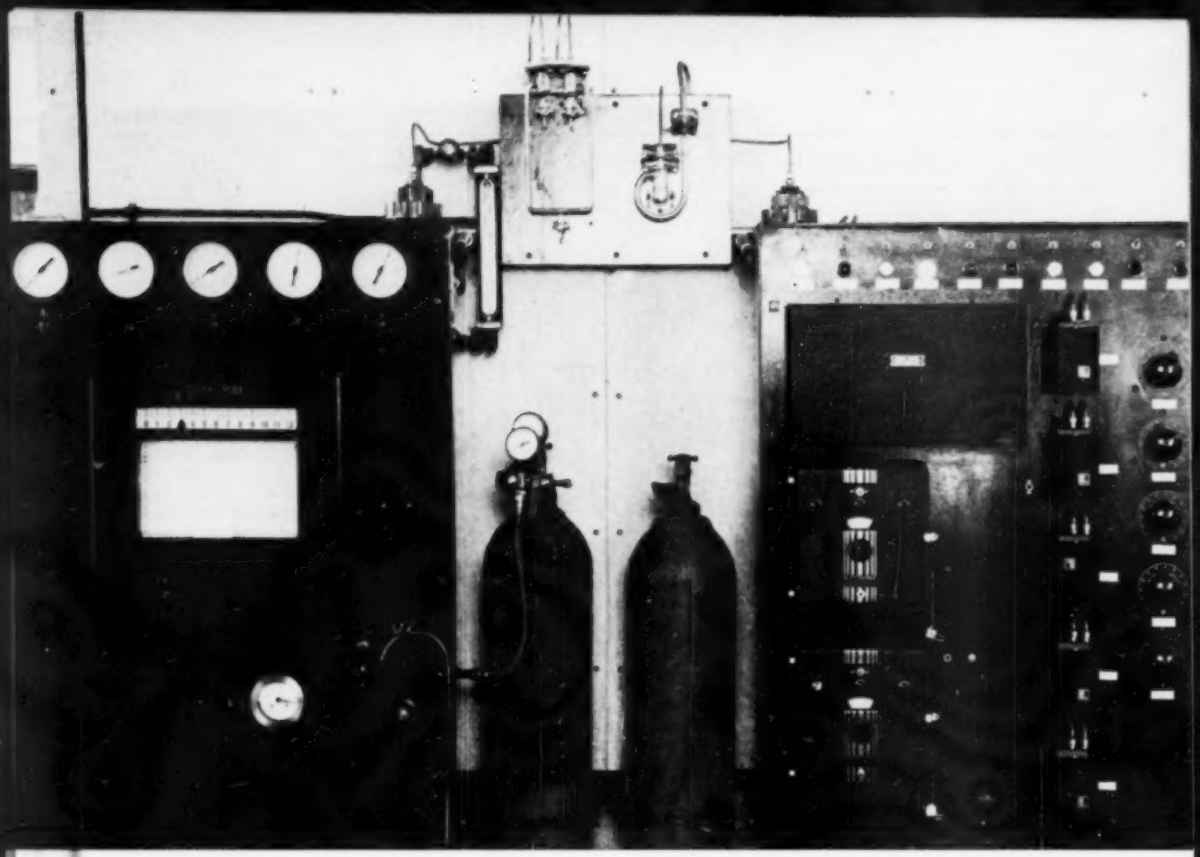
A schematic curve of tube life-expectancy is shown in Fig. 1. The upper curve is the maximum life which has been exhibited by any one tube which has been run in the furnace position shown. Below it is the average life from the histories of all tubes which have been run in each of the positions. "Average life" is not determined by "splitting the difference" between the shortest and longest-lived tubes but is the life shown by the greatest number of tubes on the basis of engineering judgment. It may be determined statistically or by plotting distribution curves for each tube position.

A schematic tube-life chart is shown in Fig. 2. Positions on the X-axis denote radiant section tube positions, numbered from the coil furnace inlet in this case. On the Y-axis are divisions representing length of service. These may be days, weeks or hours. Below the tube position may be noted the date when the tube was installed and whether new or salvaged. Drawn on the chart also is the average life expectancy of tubes in that position.

As frequently as desirable, the bar representing the actual service time for the tube is correspondingly lengthened. When the bar approaches the average service life plans should be made for replacement. Since it normally takes but little more time to replace several tubes than only one, the engineer will schedule several tubes for replacement at the same time, even though some sacrifices have to be made in the service life expectancy of some tubes. Those tubes which normally would be all replaced simultaneously are indicated by the relatively short horizontal bars touching the average-life curve.

Fig. 2 also shows two other things which may be indicated by a tube-life chart. In one case, in a group of several tubes (Nos. 35 to 39, inclusive) which have been in service the same length of time are two tubes (Nos. 36 and 37) which have been in a longer time. This represents the installation of experimental tubes being run to incipient failure. In the other case, there are represented several tubes having been in service the same length of time with the exception of one tube. This denotes the installation of a salvaged tube to replace one which had prematurely failed. The replacement is presumed, on the basis of past records and experience, to have the same remaining service life as do the tubes around it, and will be replaced at the same time they are.

It may be found that a tube will fail occasionally because of a faulty weld between return bend and tube (necessary construction when high pressures and temperatures are involved), carbon deposition, flaw in the metal, and the like. The remainder of the tube may be presumed capable of serving out what is left of its normal life span. Used to stub-end or repair another tube having a similar useful service life, which can be picked up from the record of individual tubes (as distinguished from furnace position records), an appreciable saving in maintenance cost may be achieved over simply discarding the tube. Likewise, such a salvaged tube, having a certain service life remaining, may be installed to replace a failed tube in a position where there are several other tubes which may be presumed to have approximately that much remaining service life. This will preclude a furnace shutdown at some future date to replace just one tube.



GOOD DIVIDENDS in improved operations are claimed for the automatic catalyst aging equipment described in this article. The equipment operates 24 hours a day, unattended except during regular working hours, and controlled by a cycle timer and the instruments shown above

Selection of Cracking Catalysts With Aid of Laboratory Aging

By C. K. VILAND, General Supervisor
Western Division Research and Development Laboratories,
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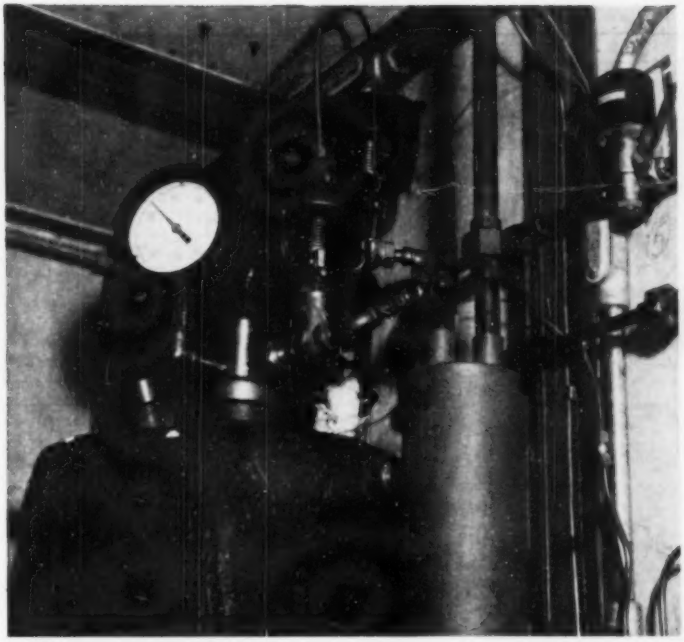
The trend toward charging heavier distillates to catalytic cracking has focused attention on the importance of adequate laboratory methods to indicate catalyst aging characteristics in commercial operations. A laboratory tool for aging catalysts is described, as modified from an earlier published procedure in the manner of control, time cycle, method of distribution of air through the catalyst, and safety provisions, among other details.

EVERY refiner using a catalytic cracking unit commercially is faced from time time with the problem of choosing the catalyst best suited to his particular requirements. Those responsible for catalytic cracking operations are interested in knowing the effect that available oil feed stocks have on useful life of catalysts.

The trend toward charging heavier distillates to catalytic cracking, which may also be of high sulfur content or poorly fractionated, focuses attention for the need for adequate laboratory methods to indicate attendant catalyst aging characteristics.

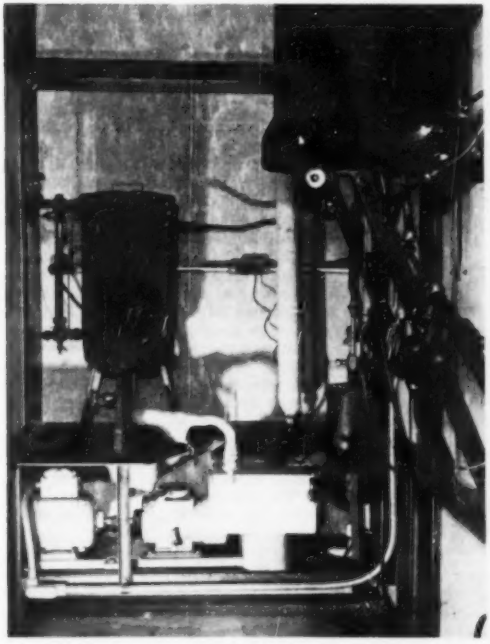
In normal aging of catalysts loss of surface area is observed. Such aging does not appreciably effect selectivity to produce original proportions of gas, gasoline and coke when cracking at a given conversion level, if operating temperatures are unchanged. Abnormal aging on the other hand may occur in both natural and synthetic catalysts from contamination with heavy metals entrained in the feed stocks, particularly iron, nickel, vanadium and copper. Even minute amounts are harmful in that they increase coke producing tendencies. Poisoning metals are said to occur in the form of completely vaporized compounds as well as by entrainment of heavy salts normally retained in the residue.

However, a more common reason for abnormal aging or loss of selectivity applies to some commercial clay catalysts, but not to synthetics, because iron naturally present is brought into a catalytically active state through reaction with sulfur compounds contained in feed stocks. This reaction of iron with sulfur

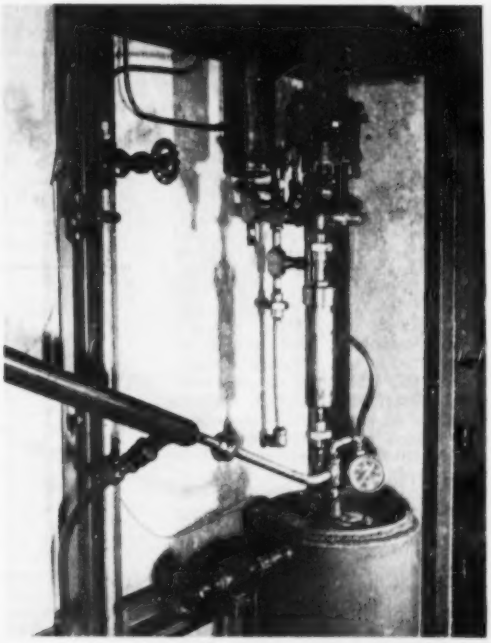


TOP OF REACTOR used for aging catalysts. The preheater (shown in photo at right) and reactor are located in a 1¼-in. stainless steel tube 3 ft. long, and jacketed by a heavily-insulated tank containing Houdry heat transfer salt. The salt bath is held at 850° F. during operation

PREHEATER PLUG, air distributor and catalyst basket. The ⅛-in. square-thread path in the plug is 131 in. long



FEED TANK AND PUMP at left, reactor outlet at right. Feed is charged at rate of 11.5 ml per minute



SYNTHETIC CRUDE RECEIVER. Blended product is analyzed daily to determine gasoline content

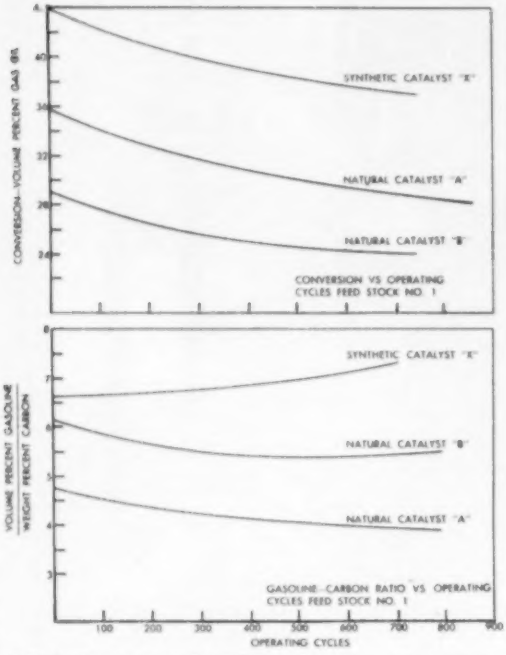

CONVERSION—VOLUME PERCENT GAS OIL
SYNTHETIC CATALYST "X"
NATURAL CATALYST "A"
NATURAL CATALYST "B"
CONVERSION VS OPERATING CYCLES FEED STOCK NO. 1
VOLUME PERCENT GASOLINE / WEIGHT PERCENT CARBON
SYNTHETIC CATALYST "X"
NATURAL CATALYST "B"
NATURAL CATALYST "A"
GASOLINE—CARBON RATIO VS OPERATING CYCLES FEED STOCK NO. 1
OPERATING CYCLES

FIG. 1—Comparison of catalysts, when using one commercially available feed stock

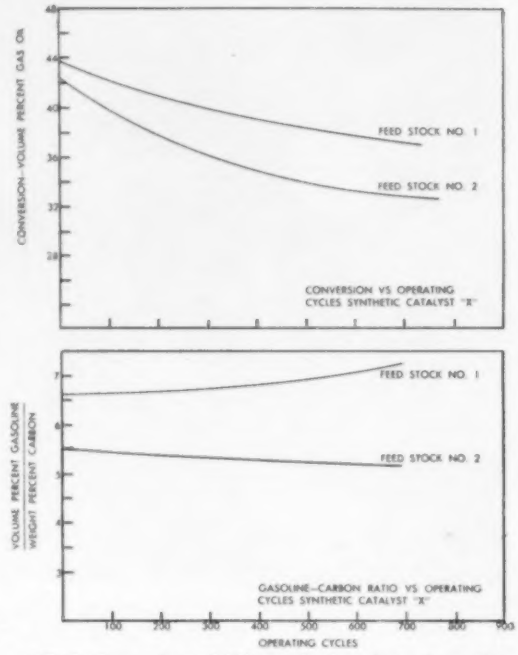

CONVERSION—VOLUME PERCENT GAS OIL
FEED STOCK NO. 1
FEED STOCK NO. 2
CONVERSION VS OPERATING CYCLES SYNTHETIC CATALYST "X"
VOLUME PERCENT GASOLINE / WEIGHT PERCENT CARBON
FEED STOCK NO. 1
FEED STOCK NO. 2
GASOLINE—CARBON RATIO VS OPERATING CYCLES SYNTHETIC CATALYST "X"
OPERATING CYCLES

FIG. 2—Comparison of different feed stocks to show effect on one catalyst

compounds may be partially prevented by the presence of water vapor, and for this reason prehydration of natural catalyst before it enters the reaction zone is extensively practiced [1, 2].

There are now in general use several kinds of cracking agents. Synthetic catalyst manufacturers offer variations of the silica-alumina material now in wide commercial use and also newer silica-magnesia compounds. Other compositions have been developed in the laboratory such as silica-zirconia and alumina-boria. Natural catalysts also are available in several types and grades, the most common being an acid treated bentonite clay known as super-filtrol. The principal constituent of this catalyst is the clay mineral montmorillonite [3]. Natural catalysts of lower iron content and of improved aging characteristics are now available commercially. It is understood these may be produced from usual mineral sources by special treating methods [1], or by starting with selected raw materials of initially low iron content.

Both synthetic and natural catalysts are available in ground powder form. Synthetic is also obtainable in the form of microspheroidal particles for fluid-flow units. Again both synthetic and natural catalysts may be purchased in the form of pellets for cracking processes using fixed or moving-solid beds, and the synthetic also as "beads". Often the physical form and manufacturing methods used to achieve the desired shape, as well as chemical or other variables, have significant effects on cracking characteristics. Operators may have difficulty interpreting available data unless a large amount of commercial experience is at hand.

A useful laboratory tool for aging of cracking catalysts was described by Rice and Ivey at the 27th Annual Meeting of the American Petroleum Institute [4]. Basically the equipment is a small fixed-bed catalytic cracking unit capable of fully automatic operation over a sufficiently long period of time to determine rates of decline in catalyst activity and changes in product distribution. Seven to eight hundred cracking and regeneration cycles usually provide adequate information to evaluate a catalyst or a feed stock.

Such an apparatus has been in operation for about two years in the Western Division Research and Development Laboratories of the Tide Water Associated Oil Co. at Avon, Calif. It differs somewhat from Gulf's unit as described by Rice and Ivey, with reference to manner of control, the time cycle, the method of distribution of air through the catalyst during regeneration, and in other details [5].

The mechanical brain that operates the cracking unit is a cycle timer; it controls electrical circuits and opens and closes magnetic and also electrically piloted but pneumatically operated valves in predetermined sequence.

To insure safety in fully automatic operation when unattended at night, all component parts excepting the meters, automatic controls and

Meet the Author

C. K. Viland has been general supervisor of research and development of the Western Division of Tide Water Associated Oil Co. for the past four years. He is a graduate of the Colorado School of Mines, and has been with Tide Water since 1929. He is located at their Avon refinery in the San Francisco Bay area.

the wet gas condenser are located in a fire-proof transite box 4 ft. wide, 8 ft. long and 10 ft. high. An automatic device was installed which shuts the unit down in case of fire, or in event of excessive pressure or leaks. Should a momentary power failure of less than 30 sec. occur, a time-delay relay stores sufficient energy to start the unit again when electric power is resumed. Fire protection is provided by a CO_2 system triggered by a thermostat. An alarm system is included in the fire protection device.

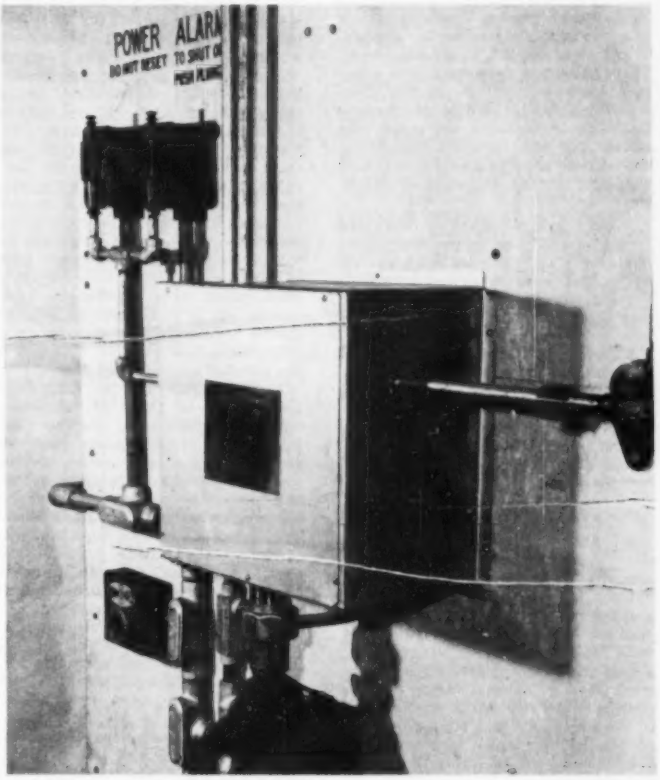
This laboratory unit operates on a 30-min. time cycle. Because of the heavy nature of the California feed stocks to be studied it was found impracticable to operate on the customary 10-min. reaction period and the sequence shown in Table 1 is used.

To prevent the temperature of the catalyst from rising above a maximum of 1100° F. during regeneration, a distributor was devised which would spread regeneration air evenly through the catalyst and allow the carbon to burn off at a lower temperature.

Preheater and reactor are located in a 1¼ in. stainless steel tube 3 ft. long jacketed by a tank containing Houdry heat transfer salt. The stainless steel screw-type preheater plug in the top of the tube is machined from a solid piece of stainless steel. Oil is brought up to temperature in passing through the ⅛-in. sq.-thread path 131 in. long. A ¼ in. tube extends through the center and is connected to a hairpin shaped drilled air distributor reaching into the catalyst bed. The reactor section is provided with a perforated basket 21 in. long with a screen 11 in. from the top. Above the screen 200 ml. of ¼ x ⅛ in. pelleted catalyst is supported.

It will be noted that the catalyst is placed near the center of the salt bath, and this was done to insure more uniform temperatures. The salt bath is heated by two individually and automatically controlled electric heating elements, plus one manually controlled heater at the bottom to compensate for heat losses. The entire unit is heavily insulated. The bath is held at 850° F. during operation. Cracking temperatures are slightly above this figure at the start of each reaction cycle and lower at the end, but average close to the salt reading.

A Zenith gear pump with a variable speed transmission and two No. 1 size pumps provides an extremely accurate control over the rate of feed to the reactor. Charge rate during the 4 min. cracking period has been standardized at 11.5 ml./min. A heating unit around the pumps is necessary because of the high pour point of some feed stocks.



AUTOMATIC SAFETY DEVICES shut down the catalyst aging unit in case of fire, or in event of excessive pressure or leaks, and a thermostat-triggered CO_2 system provides further protection

A Stokes Model F single punch pelleting machine is used to form pellets from powdered fluid cracking catalyst. Although a pressure of four tons is exerted in pelleting, a special technique is required to form the pills without using a binder. The powdered catalyst is thoroughly dried at 230° F. and pelleted while hot. Fracturing of the pills in the machine was overcome by tapering the die and slightly flattening the end of the punch. The pellets are calcined at 1000° F. for 16 hrs. in a stream of air before use.

Dry gas and the blended synthetic crude from the primary water-cooled and the secondary refrigerated receivers are analyzed for light hydrocarbon composition daily. A high

TABLE 1—Sequence of 30-Minute Time Cycle in Catalyst Aging Test

Cam No.	Operation	Minutes Off	Minutes On
1	Pressure release after regeneration	0:00–	5:00
2	Nitrogen purge before on stream	0:30–	5:00
3	On stream (feed valve and pump)	5:00–	9:00
4	Synthetic crude and gas valves (last 30 sec. draining to receiver)	5:00–	9:30
6	Vacuum after on stream	9:30–	15:00
7	Vacuum and nitrogen purge	11:00–	15:00
9	Safety bypass	11:00–	5:00
8	Regeneration air through Solenoid Valve	15:00–	30:00
5	Regeneration air through catalyst (air both through distributor and into top of catalyst)	15:00–	25:00
10	Regeneration air through nitrogen valve (air through preheater and through catalyst from top only)	25:00–	30:00
	Recapitulation	Minutes	
	Pressure release and nitrogen purge	5	
	Cracking period (at 0 psig.)	4	
	Purge, vacuum and nitrogen	6	
	Regeneration (at 40 psig.)	15	
	Total	30	

temperature precise fractionation is also made to determine the content of gasoline in the synthetic crude. These data are corrected to a common basis of 390° F. at the 90% distilled point by ASTM distillation. Coke determinations are made by converting any carbon monoxide in the regeneration gases to CO_2 and weighing the CO_2 absorbed in Caroxite.

Results are tabulated on standard forms for ready reference, and charts made up with chronological cracking cycles as the abscissae and with conversion, gasoline yield, carbon make and a product ratio (vol. % gasoline over wt. % coke) as the ordinates.

Figs. 1 and 2 show essential data used in two typical evaluation studies. The first example compares catalysts when using one commercially available feed stock; and the second chart shows effects of different feed stocks on one of these catalysts.

The upper set of curves for each of these examples portrays conversion with every operating cycle as time goes on; and the lower ones compare a convenient product ratio, vol. % of gasoline with respect to amount of carbon yielded, as the catalyst is used. When considered with the conversion versus time curve, the lower graph gives an indication if abnormal aging is occurring. All catalysts are subject to normal aging and conversion will decline in use under any set operating conditions, therefore both plots are required.

Since conversion may be varied by adjusting space velocities in commercial units to compensate for catalyst activity changes, the lower or product ratio chart may be corrected if desired to show the gasoline/carbon ratio at constant conversion by use of an appropriate set of lines on semi-logarithmic paper.

In the first example (Fig. 1), the cracking of Feed Stock No. 1 with synthetic catalyst "X" having an initial UOP weight activity of 100 resulted in a higher initial conversion than either natural catalyst "A" having a UOP weight activity of 45 or natural catalyst "B" with a starting activity of 24. The conversions obtained under standard operating conditions were proportionate to activities of the catalysts, as would be expected. The gasoline/carbon ratios however are quite interesting. In this comparison, the synthetic catalyst was subject to only normal aging as the ratio of gasoline to carbon yielded did not change appreciably when corrections are made for conversion level.

The apparent favorable increase in the gasoline/carbon ratio is nullified if correction is made for the declining conversion obtained under the standard conditions of the test. Natural catalysts "A" and "B" suffered abnormal aging; however, catalyst "B" of lower activity produced a better product distribution at all times than catalyst "A" in spite of the unfavorable difference in activity. Catalyst "B" contained only one-third as much iron as catalyst "A".

Fixed-bed comparisons of this type may be used as a basis for an economic evaluation in the selection of catalysts. However, it is always desirable to have as a reference point sufficient commercial or conventional pilot plant data which give firm figures on actual make-up requirements in maintaining desired product distribution for one or more of the catalysts being compared.

In the second example (Fig. 2), a comparison of two feed stocks is made using synthetic catalyst "X". Feed Stock No. 2 causes moderate abnormal aging since both conversion and product distribution are affected as the catalyst ages. Table 2 gives the properties of Feed Stocks Nos. 1 and 2.

Equipment of this type is also useful for other research projects. Among the first work scheduled in the Avon automatic fixed-bed unit was a series of runs to determine the desirability of prehydrating natural catalyst when processing certain feed stocks. Runs were made with and without steam injected into the catalyst bed during a 3½ min. period after each regeneration. This was done by operating a small water pump with the cycle timer. Effects from such hydration included:

1—An increase of 50° F. was observed in the catalyst bed as steam was added. The steam being used was at a temperature of 300° F. and the catalyst bed about 880° F. at the start of the injection period. Considering the normal drop in catalyst temperature from the regeneration peak with the salt bath held at 850° F. the heat released was sufficient to have raised the catalyst another 10° F.

2—The regeneration temperature was depressed so low by subsequent dehydration that it was necessary to use 84% additional air to insure sufficiently rapid burning to reach a peak of 1045° F. This same feed, without steam, produced a maximum regeneration temperature of 1095° F.

3—Steam was adsorbed to extent of an estimated average of 1.05 wt % of the catalyst per cycle during the test.

4—The effect of prehydration on aging of natural catalyst "A" when processing Feed Stock No. 2 may be summarized as shown in Table 3.

TABLE 2 — Properties of Feed Stocks Used in Catalyst Aging Test

	No. 1	No. 2
Gravity ° API	25.1	20.5
Distillation—° F.		
IBP	506	463
10%	640	662
50%	757	758
90%	873	...
Viscosity S.S.U. @ 100° F.	111	273
Aniline Point ° F.	175	151
Pour Point ° F.	75	75
Carbon Residue—Wt. %	.15	.21
Sulfur—Wt. %	.50	.80
Nitrogen—Wt. %	.28	.31
Ash—Wt. %	.0015	.004
Nickel—parts/million	.27	.65
Vanadium—parts/million	.29	1.06

TABLE 3 — Effect of Prehydration on Aging of Natural Catalyst

	No Hydration	With Hydration
At Start, New Catalyst		
Conversion	34.0	35.0
Gasoline—Vol. %	28.2	29.4
Carbon—Wt. %	6.6	6.2
Ratio	4.3	4.7
After 700 Cracking Cycles		
Conversion	26.7	27.2
Gasoline—Vol. %	19.5	22.8
Carbon—Wt. %	6.7	5.7
Ratio	2.9	4.0

The advantages of obtaining supplementary data in a more conventional pilot plant where process variables and product distribution are subject to direct correlation with commercial operations are obvious. At Avon a small fluid catalytic cracking pilot plant is used in conjunction with the fixed-bed apparatus for most catalytic cracking research. This unit, unique because of its small size, is basically of Universal Oil Products Co. design and operates on a charge of about 3 lbs. of fluid cracking catalyst. Fines are first removed to facilitate movement in the small lines and to simplify recovery problems, equipment therefor consisting of simple cyclone separators. The Fluid pilot plant will process 150-600 ml. or more of oil feed per hour depending on space velocities desired. Because of its small size it will quickly reach equilibrium operating conditions, and it is normal practice to start up, obtain a set of samples under predetermined test conditions for yield data, and shutdown, all within a single 8 hr. work shift.

Automatic catalyst aging equipment of the type described and appropriate laboratory auxiliaries will often pay good dividends, since plant management is generally properly reluctant to experiment on a commercial scale with what may be considered a satisfactory operation.

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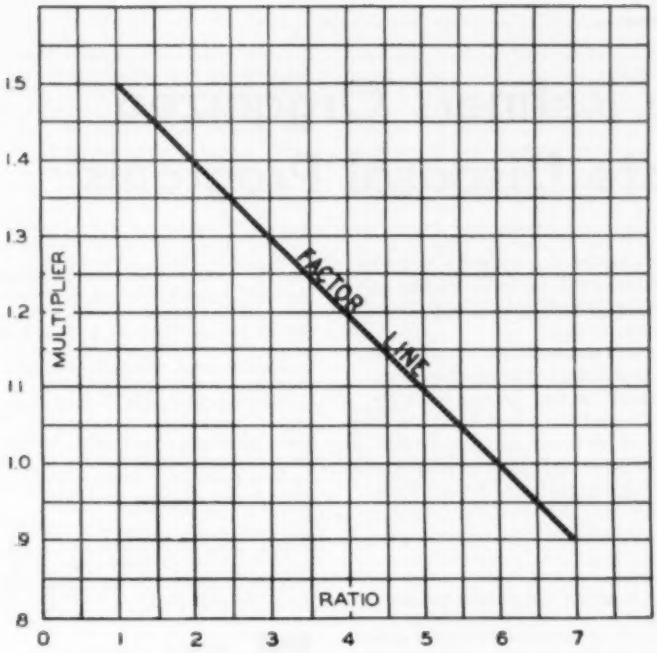


FIG. 1—Ideal center distance chart. To use: locate the ratio on the base line and trace imaginary line vertically to the factor line, then horizontally to multiplier on scale at left. The multiplier times the diameter of the large sheave equals the ideal center distance

Chart for Best Center Distance Uses Vee-Belt Sheave Ratios

By FRANK H. RUMBLE, Texrope Drive Dept., Allis-Chalmers Mfg. Co.

AMONG various advantages to the petroleum industry in the use of the V-belt drive is its ability to operate on extremely short center distances, desirable particularly from the standpoint of economy and compactness.

Using the shortest practicable, or "ideal center distance," on any V-belt drive lowers initial cost as well as maintenance cost. Short belts are lower in first cost and for replacements when they become necessary. They require less adjustment. It is also easier to maintain the proper tension because there is less belt to stretch and get out of adjustment.

Compactness and space saving alone, of course, can be solved by direct connection of the prime mover to the driven machine. However, this method of power transmission is practicable only when the speed of the driven machine need not be different than the speed of the motor or prime mover and where no shock load is present. In other words, another advantage of the V-belt drive, and one which works hand in hand with the short center feature, is that small or relatively large ratios—up to 7/1 and over—may be used to obtain the exact rpm desired in the driven machine. Furthermore, the resiliency of the V-belts themselves allows peak loads and heavy starting torque to be absorbed without transmitting shock to either the driving unit or the driven machine.

In practice, the center distance—distance between shafts—of a V-belt drive may be comparatively long or it may be as short as diameters will allow without the sheaves actually touching each other. Experience has shown that the shortest *practicable* center distance is the sum of the radii of the sheaves plus enough margin to enable the sheaves to be moved toward each other sufficiently for installing or changing belts. A margin of anywhere from several inches on fractional horsepower drives to several feet on the largest multiple drives may be sufficient for this purpose. However, because it is not always possible or desirable to use the very shortest center distance, the designer is given some leeway.

Arc of contact of the belts on the sheaves must be taken into account to obtain the best drive with the fewest number of belts. For greatest operating efficiency, the arc on the smaller sheave should never be less than 90°. Taking all of these factors into consideration, as a general rule the ideal center distance of the drive, up to 7/1 ratio, is from one to one and a half times the diameter of the large sheave. On larger ratio drives, the center distance may be slightly less than the diameter of the large sheave.

Fig. 1 is a chart for determining the ideal center distance proportionately. Assume the diameter of a driven sheave is 30 in. It is obvious that if the diameter of the driver sheave is also 30 in., the center distance of the drive must be considerably more than 30 in.—the sum of the radii of the sheaves alone is 30 in. and in that space they could not be belted.

Note, however, that for 1/1 drives, the rule allows a center distance of 1½ times the diameter of the driven sheave. In this case the ideal center distance would be 45 in. If the diameter of the smaller or driver sheave is five in. a 6/1 drive a multiplier of one times the diameter of the driven sheave shows the ideal center distance to be 30 in. Similarly, the chart can be used to determine the approximate multiplier for calculating the ideal center distance for drives of any ratio.

Many V-belt drives now operating satisfactorily have a longer distance than is necessary, yet the longest centers found on V-belt drives are short when compared with flat or other types of belt drives.

To enable the engineer to design any drive with a center distance as near the ideal as possible, V-belt manufacturers have standardized on a considerable number of lengths in the five standard belt sizes—A, B, C, D, and E sections. It is usually possible to select stock belts and sheaves, and by varying the size of the sheaves while keeping the same ratio, to obtain almost the exact center distances desired. This must be, and can be done without violating any of the basic principles of good V-belt engineering, such as recommendations concerning minimum sheave diameters or excessive belt velocity. Use of the short center is very desirable, but it should not, and need not, be attained at the sacrifice of efficiency and long life of the drive. It is possible to have all three.

How Five Refiners Organized Their Waste Disposal Programs

The increased public attention being given to stream and air pollution from industrial and other sources has led to the setting up in many refineries of special technical groups who are in direct charge of the plant's pollution control program.

Inside the refinery gate, these groups supervise the operation of the waste disposal system, reporting regularly to the plant management and suggesting changes in methods as they become desirable to meet plant operating conditions. Outside the plant, the head of the group at least watches pollution control crusades and developments in the plant area, reporting these to the plant manager.

The personnel organization handling the pollution control work, its duties, responsibilities, reports made and to whom, are described below as reported to PETROLEUM PROCESSING by five refining companies.

1 The Texas Co.

By J. S. Worden, Manager (Operations) Refining Dept., The Texas Co., New York

IN The Texas Co. we have no fixed system of responsibility for proper functioning of the pollution control systems. The highest management has so emphasized the importance of the entire matter that plant managers or superintendents devote considerable personal time to investigation, inspection, contacts with control agencies and so on.

The individual actually in charge of the detailed operation of the waste disposal system may be the supervisor of the treating plant and/or oil movements, or in some plants a specific department may be organized to handle this work. The necessary technical assistance is provided by the plant laboratory or process or structural engineering departments.

The corrective organization may be broadly outlined as handling everything pertaining to observation and correction of undesirable pollution conditions, both water and air as well as such intangible items as noise and vibration. It usually reports directly to top management, but never to a man of lower rank than assistant manager or superintendent.

Analyses of effluents and other inspections of waste materials are made as deemed necessary for individual conditions. In general, such items as pH, oil content, sulfides, phenols, total solids and suspended solids are covered at such intervals as required to satisfy management as well as the enforcement agencies. B.O.D. (biochemical oxygen demand) is taken occasionally and at some locations air analyses of stack effluents are taken to cover hydrogen sulfide, sulfur dioxide, dust count from catalytic processes, and so on.

The regularity with which analyses and inspections are made varies from a weekly sample to continuous sampling, depending upon locality, severity, etc.; pH recorder-controllers are in common use and smoke recorders and recording anemometers are used.

The type of reports made will vary, but generally they will include a daily record of conditions, the report going to supervisors of not less than assistant superintendent rank, and usually the manager or superintendent. This individual then handles with the proper party for improvement or calls upon the technical staff for investigation.

Group meetings on specific problems are held by top plant management and attended by the foremen of the department concerned and such technical assistants as necessary. If required, a long range research or development project is outlined and the necessary requests for appropriation is made. Sometimes experts from another plant or from the head office of the company are sent to assist in specific problems.

The individual who follows the general pollution control program in the area is usually the plant chief chemist or process engineer. There is a definite policy of cooperation with adjacent plants on mutual pollution control problems, using a committee composed of top management with other committees made up of chemists and engineers. Problems and methods are discussed openly.

Company representatives both from the head office and from plants serve on the various API waste disposal committees and information coming from these groups is disseminated within the company by these representatives. At one location the plant managers meet regularly on pollution control matters and periodic detailed investigation of disposal facilities is made by the heads of the refining organizations in that locality. The feeling behind this group activity is that pollution may be considered an industry problem in addition to being a company problem, for generally a particular industry or even industry in general is blamed for pollution conditions rather than an individual company and legislation may be based accordingly.

2 Atlantic Refining Co.

By W. B. Hart, Superintendent of Services, Atlantic Refining Co., Philadelphia

IN THIS company a sanitary engineer is the head of both operating and laboratory activities in waste treatment and control, his responsibilities extending to both the Philadelphia and Atreco refineries. He reports to the Superintendent of Services for general scheduling of work, policies and so on. Watching pollution control developments outside the refinery is a function of top management.

In the Philadelphia refinery the sanitary engineer's organization is divided into two parts. The operating section is in charge of a supervisor who maintains a staff of approximately 45 men, on a 24-hour basis, for the operation of separators and waste treatment practices. The laboratory section of the sanitary engineer's department is in charge of an assistant sanitary engineer and a laboratory supervisor.

The assistant sanitary engineer with about 5 engineering assistants handles the design and engineering investigations necessary to the development of waste treatment processes. The laboratory supervisor with about 5 assistants conducts analytical and other testing work as needed by the engineering group makes investigations of a biological and chemical nature and keeps a running examination of effluents from the plant. This division also maintains a continuous check on river quality.

Their examination of the effluents is made to determine oil, total dissolved solids, B.O.D. and similar tests. They also conduct toxicity tests to determine overall condition of the effluent. All these tests are on a daily basis.

All activities of the waste control group are reported to the sanitary engineer in charge, who periodically reports to the service superintendent when conditions are normal, but immediately reports abnormalities. When abnormal conditions persist, indicative of a change somewhere in plant operations, an investigation is started and plans developed either to correct the condition within the operating unit, or to devise a treatment procedure to eliminate the undesirable characteristic. In this way, there is a continuous contact between waste control activities and management and very little can happen that is not known to management almost immediately after it occurs.

3 Cities Service Oil Co.

By J. S. Baum, Foreman, Light Oils Dept., Cities Service Oil Co., East Chicago, Ill.

IN ORDER to have effective control over all waste disposal systems in our refinery, the Light Oil Department Foreman is responsible for all waste disposal, covering both stream and atmospheric pollution. The direct handling of the oil-water separators is under the direction of the pumping department foreman. In the case of atmospheric pollution the points of emission are such that each individual operating department foreman is directly responsible for any atmospheric pollution.

The department foremen operate their waste disposal systems to obtain greatest efficiency, making the necessary operating changes. In case of trouble they report to the individual in charge of pollution and problems of a minor nature are handled at this level. Major problems or projects requiring reasonable expenditures are referred to management for approval.

In the case of waste water effluent, visual inspection is relied on to a great extent. However daily oil content determinations are made and reported. Other laboratory analyses on the waste waters are run at less frequent intervals as a matter of record, to determine if the nature of the wastes has changed materially. In air pollution, odor and visual inspection only are required to meet current air pollution requirements.

To keep management informed of necessary changes in the disposal systems, complete reports are made, with the necessary laboratory data to support the suggested change. In the case of smoke abatement we have found photographs greatly support laboratory data when making up reports. The reports are fully discussed with local management and then sent to the General Superintendent's office for approval.

The Light Oil Department Foreman is responsible for following the general pollution control program in the area and, in order to keep informed on the subject, he is a member of the API Waste Disposal Committee. All information, both local and outside of the area, is reported both to local management and the General Superintendent's office.

4 Sun Oil Co.

By W. E. Soden, Engineering Divison, Manufacturng Dept., Sun Oil Co., Philadelphia

THE group in charge of the waste disposal system at the Marcus Hook refinery consists of a general foreman, supervisory foreman and two assistant foremen.

One assistant foreman, with 15 men, handles separator operations. The other assistant foreman, with 3 men, operates the chemical treating facilities. The assistant foremen aid each other and the supervisory foreman in inspections and operating functions.

The frequency of the inspections and analyses of effluents, which are conducted by the foremen, depend on the pollution potential of the particular effluent stream, and range from twice daily to once weekly. In addition, operating personnel maintain round-the-clock surveillance as part of their duties.

Routine weekly composite samples, made up of samples taken every four hours, are taken on all major effluent streams. In addition, operating personnel report any unusual condition immediately to the appropriate area foreman. Samples are taken to determine the nature of changing wastes when needed, with the assistance of the Development Department.

Monthly reports containing effluent analyses are sent to the state and federal authorities. The operating department prepares monthly and annual data reports and annual progress reports are submitted to the plan management.

Suggested changes in the waste disposal system can be submitted by operating, engineering or development personnel. Close contact between all three groups is maintained so that new proposals can be screened without delay. Development and investigatory work is assigned as necessary with the cooperation of a pollution abatement laboratory. Recommendations for changes coming from the waste disposal group foremen are forwarded to refinery management and acted upon by the engineering department.

The Head of Pollution Abatement of the engineering department and his staff follow the waste control program in the individual refinery and keep abreast of all outside developments.

5 Pan-Am Southern Corp.

By J. D. Tufts, Refinery Superintendent, Pan-Am Southern Corp., Destrehan, La.

WASTE disposal at our refinery is under the supervision of the engineering department which supervises the oil trap operator who spends his full time tending the waste disposal and oil recovery equipment.

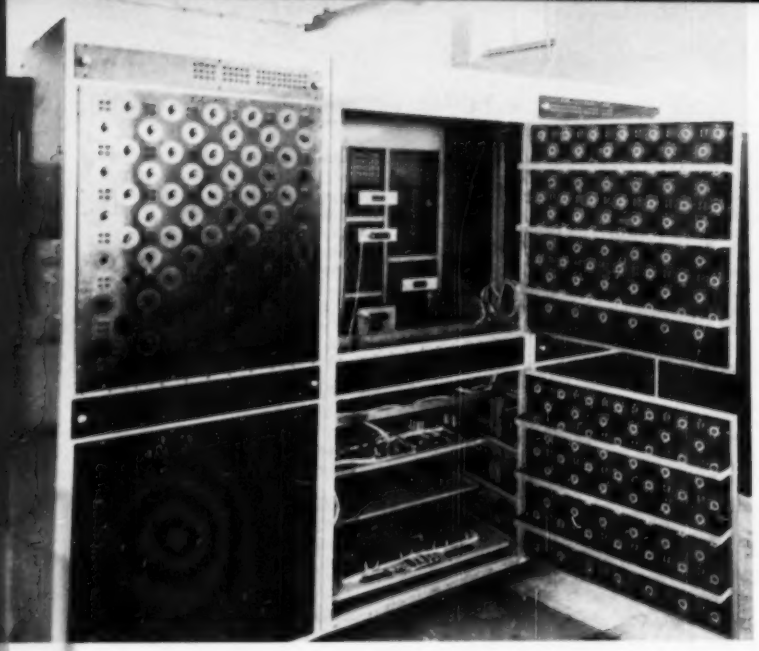
The duties of the oil trap operator include: (a) tending the oil skimmers, (b) periodically pumping the sludge from the bottom of the trap so that it operates at maximum efficiency; (c) checking to see that the labor department has changed the hay in the baffle; (d) reporting to the engineering department any repairs or changes that should be made; (e) reporting any unusual amount of oil entering the trap and its possible source, so the trouble may be traced.

The refinery laboratory does not have the facilities for analyzing effluent water. However, the refinery is a member of the Louisiana Petroleum Refinery Waste Control Council and it may at any time send a sample to the Louisiana State University laboratory for a complete analysis, including such tests as toxicity, B.O.D., dissolved oxygen, etc. The analyses are made by two graduate students who are on fellowships sponsored by the Council for the purpose of extending the scientific knowledge in the field of stream pollution and toxicity of refinery effluent on wild life.

The effluent water analyses are made only when the engineering department thinks necessary due to some unusual plant operation which might affect the waste water which is normally non-toxic to marine life. Results of the analyses are reported to the refinery superintendent.

When changes in the waste disposal system are deemed advisable by the engineering department, appropriation requests are made up and forwarded to the management for authorization.

It is the duty of the chief engineer at the refinery and his assistant to follow the plant pollution control program and to attend the quarterly meetings of the state Refinery Waste Control Council and keep informed on developments in this field outside our own refinery.



RECURRING ANALYTICAL PROBLEMS in refinery processing operations can be solved with reliability and at a considerable saving in time and money with analogical-type computers, such as the one shown above. This computer, designed and built by Phillips Petroleum Co., is used first to analyze petroleum reservoirs and then to predict their future behavior

ANALOGICAL COMPUTERS

Role of Special 'Mathematical Brains' In Solving Processing Problems

By W. L. MORRIS and F. W. BUBB
Phillips Petroleum Co. Research Dept.

IN THE past decade there have been constructed and placed in operation several universal, widely applicable computers, such as the ENIAC, the IBM - Harvard Computer, and others. Due to the size of these machines and their ability to cope with almost any mathematical problem, they have attracted much attention and have, in the process, obscured the concurrent development of numerous smaller computers designed to work day by day in the solution of special analytical problems which are recurrent in the process and other industries.

In the operation of certain industrial processes, it is necessary to solve the same problem repeatedly. For such specialized use, a universal computer is neither needed nor appropriate. Instead, one needs a special computer to do the problem in hand. Such special computers should be reliable in operation, capable of continuous operation over extended periods, and of minimum size and cost. It has been found that a certain type of computer known as the analogical type is peculiarly adapted to these requirements.

In contrast to the universal or digital type of computer, which deals only with numbers, the analogical type of computer is a physical system concerned with physical quantities. The industrial process to which the analogical computer is matched is ordinarily described by mathematical equations. The analogical computer is made so as to be governed by the same equations, and so that each quantity in the prototype process has its analog in a specific quantity of the computer. For example, a temperature in the prototype process may be represented in the computer by a shaft rotation, or a voltage, or by some other quantity. It is the analogical type of computer with which we are concerned in this paper.

Analogical computers are used effectively in three types of problems:

1—Those in which analytic methods entail lengthy trial and error procedures.

2—Those in which boundary and/or initial conditions are complex.

3—Those in which rapidity of attaining a solution is essential to the success of the operation.

A frequently encountered type of problem to which analog computers are adapted is that for which there is no convenient analytic method for the direct computation of an answer. A problem of this kind exists in the solution of phase equilibria in the flash vaporization of mixtures of hydrocarbons. In this problem, the determination of V, the fraction of the composite hydrocarbons which is in the vapor state, involves the rather laborious trial and error solution of

$$\sum_{i=1}^{n} \frac{Z_i}{1 + V(K_i - 1)} = 1$$

where

Z_i = mol fraction of the ith compound of the mixture,
K_i = equilibrium constant of the ith compound, and
n = number of compounds in the mixture.

The human computer does this problem by guessing a value of V, inserting this into the above equation and computing the left side of the equation, which is generally found not equal to 1. Another value of V is then chosen, the left side calculated again, and so on until a value of V is found which makes the left side satisfactorily close to 1.

The "Phillips Electronic Analog Computer" was developed to solve this problem. The computer is an electro-mechanical system comprising a number of units, one for each component in the mixture. By the proper setting of potentiometers, the K and Z pertaining to each component are set on dials. The value of V which is common to all units is set simultaneously in all units by a single dial. A voltage of the form

$$\frac{E_o Z_i}{1 + V(K_i - 1)}$$

is generated by each unit and these are added and compared with E_o, the line voltage, by a galvanometer. If the galvanometer does not balance, V is varied by turning its single dial control until balance is indicated: i.e., until V is such that the above equation is satisfied. When the balance is attained, V is read from the dial. Provision is also made so that, once the equation has been solved for V, the mol fraction of each phase (vapor and liquid) of each compound may be read directly from the computer.

The analogy with the human proc-

*"An Electronic Analog Computer for Solving the Flash Vaporization Equilibrium Equation," by F. W. Bubb, R. G. Nisle and P. G. Carpenter, *Jour. Pet. Tech.*, vol. 2, no. 5, pp. 143-148 (May 1950).

ess consists in the correspondence of the cut and try choice of V with the adjustment of the dial. The pencil calculations of the human computer are performed automatically and almost instantaneously by the computer.

The second type of problem is that in which the boundary conditions are irregular. Into this class fall all potential theory problems in which the boundary itself is anything other than a circle, infinite half plane or certain other idealized forms. Two specific examples of problems of this class are: the flow of heat in irregularly-shaped bodies with non-simple boundary conditions and the flow of fluids in petroleum reservoirs.

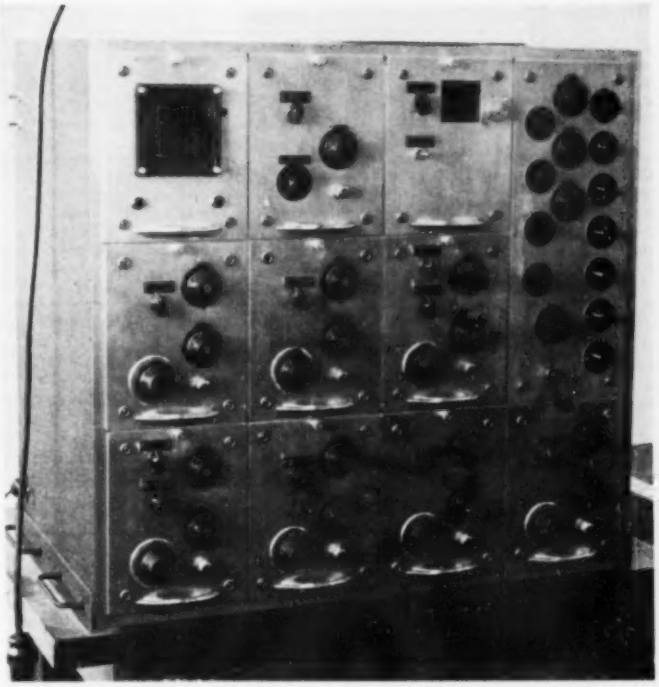
Analogical computers have been constructed to solve these problems and the two computers are fundamentally the same. The conducting medium, whether heat conducting in the former case or fluid conducting in the latter, is represented by an electrical network of resistors and capacitors. The resistance to flow of electrical current in the network is the direct analog of the resistance to flow in the medium and the capacity of the network is the analog of the capacitance of the medium to store heat or fluid. The analog of flow, either heat or fluid, is electric current, and the analog of temperature or fluid pressure is electric voltage.

By proper design, these computers can be so constructed as to be capable of application to a wide variety of problems in each field. Thus, heat flow in one medium of irregular outline and conductivity may be computed in one problem and the computer may then be converted readily to study heat flow in a completely different type and shape medium.

Similarly the computer designed to study the flow of homogeneous fluids in a permeable medium (e.g., a petroleum reservoir) is so constructed as to be applicable to almost any size or shape reservoir.

A third type of problem in whose solution analogical computers find a peculiar utility is that in which speed of attaining the solution is essential. The solution of systems of linear simultaneous equations is an example of this type. Such systems of equations arise in many places in process industry as, for example, in the infrared analysis of hydrocarbon streams in which the absorption by the stream of different frequencies of the infrared radiation yields linear algebraic equations, one equation for each frequency band of radiation used, the variables being the mol fractions of each hydrocarbon compound in the stream, and the constant coefficients being the absorption coefficients.

The solution of a system of this kind, while straightforward enough, has the practical difficulties of being



PHASE EQUILIBRIA EQUATIONS in the flash vaporization of mixtures of hydrocarbons are solved in a matter of minutes with this analogical computer, another example of these special devices developed by Phillips

tedious and lengthy when the number of hydrocarbons in the stream is four or more. Since this type of analysis is made in order to maintain the proper composition of the stream, speed of solution is necessary in order that the operator be given information with small enough time lag so that it is possible for him to maintain the stream at the desired composition.

Several computers have been made to perform this calculation. The computer in its usual form consists of a network of electrical resistors arranged in rows and columns. The coefficients are set into the machine by setting variable resistors to the pertinent values and the total extinction usually written on the right side of a linear equation, is set into the machine by feeding a voltage of proper magnitude into the proper row. In one design of this computer, the answers appear directly as voltages at the bottoms of the columns.

This latter type computer lends itself very well to the actuation of automatic controls to regulate the proper composiion of the stream.

Simulators

With increasing frequency we are coming to encounter processes, phenomena or mechanisms of such great complexity that we find ourselves in the position of knowing the end results of the process, of being able to derive but not to solve the differential

Meet the Authors

Dr. Bubb

W. L. Morris joined Phillips in 1941 as a junior engineer, and is now a member of their Research and Development Dept. He holds degrees from Carnegie Tech, university of Pittsburgh and Duke University.

F. W. Bubb, professor and head of the Dept. of Mechanics at Washington University, St. Louis, has served as a consultant to Phillips for many years.

Dr. Morris

equations governing the phenomena, and of being able to measure at most a part of the pertinent parameters of the system. In many such systems, magnitudes are such that a statistical or direct experimental approach is entirely impossible and the only known systematic approach is by construction of a "simulator".

The simulator may be a device which is indistinguishable physically from a computer and, as we shall see, we normally expect so to use the device in the next stage.

The simulator is built so as to be governed by the same differential equations as govern the prototype, and so that all variables and parameters of the prototype have their analogs in the variables and parameters of the simulator.

In operation, those parameters of the prototype which are measurable are set into the simulator and reasonable values assumed for the others. The simulator is then set in operation and allowed to proceed to the end result. This is compared with the end result of the prototype. If the two are the same, it is assumed that the simulator is a true analog of the prototype. If the two end results differ, successive adjustments of the simulator parameters are made until the two end results are the same.

Thus, we use the simulator as a substitute experimental system. Experiments may be performed on the simulator so as to give systematic direction to observations of and operations on the prototype.

Once the simulation experiments are completed, the device can be used as a computer for the solution of other problems and the study of other performances of the prototype.

An example of a simulator is furnished by application of the heat flow computer to the inverse problem of designing, say, a heat exchanger to have certain properties. In this problem, certain of the parameters such as specific conductivities and, perhaps, over-all dimensions would be known, but others, such as geometrical arrangement, would be the solution desired and hence unknown initially. In such case the heat flow simulator is set up with the known parameters and with some reasonable assumed geometry. It is then placed in operation and its result compared with the desired result. If the two differ, the parameters, such as geometry of the simulator, would be adjusted until the two results are the same. The desired design is then read off the simulator, and the simulator itself is then used to predict or to compute the behavior of such a design under varying conditions.

Another example of a simulator is found in the Reservoir Behavior Analyzer. In the case of a petroleum reservoir we frequently have a fair idea about the essential parameters of the reservoir itself, its shape, size, permeability, porosity and so on, but have very little knowledge of the surrounding aquifer which is the source of the water drive.

To obtain this information, we make use of the analyzer as a simulator. We set the known parameters into the analyzer and make reasonable assumptions regarding the unknown parameters and set these in the analyzer, also. We then operate the simulator reservoir according to the production history of the prototype reservoir, and compare the pressure history of the analyzer with that of the prototype. By varying the aquifer parameters until the two pressure histories coincide we obtain what is accepted as a true analogy between prototype and analyzer. The analyzer is then used as a computer to predict future reservoir behavior.

Automatic Control

The modern development of automatic control has been made possible only by the concomitant development of computers. In their application to, and incorporation in, automatic control systems, computers find their greatest utility. In the large sense, by this organization of the several parts into a harmoniously integrated system one achieves a final result in much the same way as an artist works out the details of different portions of a picture and then completes a masterpiece by combining them all into a coherent unity.

Simple automatic control devices such as liquid level controls have been in use for centuries. Other devices, such as thermostats, steam pressure regulators, speed governors and the like have been used for decades. Devices of this kind are generally actuated by the quantity which they are to control. For example, a gas oven thermostat will compare the oven temperature with a standard (desired) temperature and if the ambient temperature is less than the standard, the thermostat will cause the gas flow to increase. If the ambient temperature is higher than the standard, the thermostat will shut off the gas and permit the furnace to cool down. In this case, modern terminology would call the temperature the measured variable and the flow rate of gas the controlled variable.

In the control of a process, however, no such simple relation ordinarily exists between the measured variables and the control variables. For example, engineers will operate a chemical process plant by making measurements such as pressure, temperature, composition, etc., at various points in the plant. These measurements are fed into formulae, such as material balance equations, mass action relations, etc. which yield answers such as valve settings, pressures and temperatures to be used and so on. These answers are now the control variables and are such as commands to amplifiers and servos which adjust the process. In the absence of automatic controls, computations have had to be made by analytic means and the results therefrom put into effect manually.

It is now possible to accomplish this control process by construction and installation of integrated sensing—computer—control systems which observe the measurable variables, feed these results to computers which in turn determine the proper values of the control variables, transmit that information to the control mechanism which finally operates the plant in response to that information.

It should be emphasized that, while the above picture represents an ideal, it is by no means an unattainable ideal and many plants whose processes are thoroughly understood are, in fact, installing systems of this kind. Other plants whose processes are still in development may not make immediate use of full automatic control systems but can still make use of less comprehensive systems which, after the process development has been completed, can be integrated in the complete system.

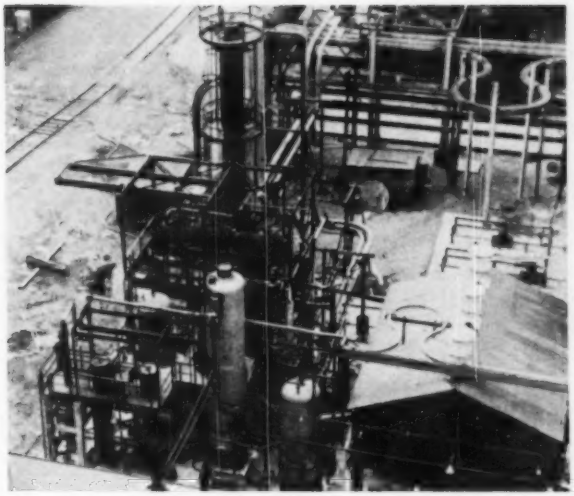
An example is furnished by the simultaneous equation solver mentioned above. The mol fractions of the various components in a liquid or gaseous mixture appear in the computer solution as voltages. Each of these voltages can be compared with a standard voltage which will be proportional to the desired mol fraction of that compound in the stream. If one computer voltage is higher than the standard, indicating thereby too great a concentration of that compound in the stream, a motor is actuated so as to turn a valve reducing that amount of that compound entering the stream. Conversely, if the concentration of that compound is too low, the valve will be actuated to increase the flow of that compound.

Conclusions

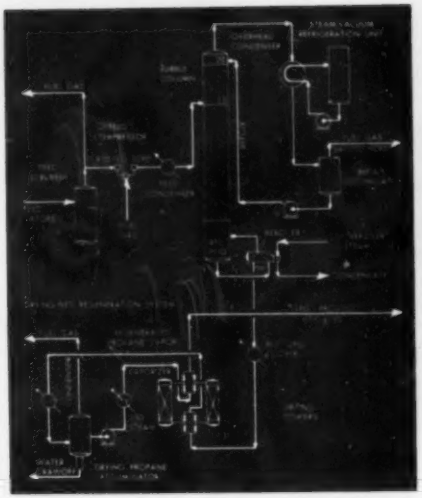
In order to be of important use to industry, analogical computers do not need to be large, of universal application nor expensive. Rather they can be specialized to solve the particular problems of that industry, to do so with reliability, and at a considerable saving of time and money.

In many industrial applications, analogical computers serve by taking on the alternate role of simulators in which they act as substitute experiments where the prototype experiment is either too expensive to perform repeatedly or even impossible to perform at all.

Finally, analogical computers find a very wide application as an integral part of modern automatic control systems.



THIS MONTH'S COVER PICTURE—New liquefied propane gas unit at Sinclair's Marcus Hook, Penna., refinery



FLOW DIAGRAM of the 1,100 b/d LPG unit, which went on-stream March 1

New LPG Unit Takes Charge From Polymer De-Propanizer

A compact separate plant designed and built by the refinery personnel recovers 85-90% of commercial grade propane of low olefinic content from the propylene-propane stream from the refinery polymer-depropanizer. The product is passed through activated alumina for drying.

By H. F. THOMPSON
Chief, Technical Department
Sinclair Refining Co., Marcus Hook

ON March 1 Sinclair Refining Co. placed on stream at its Marcus Hook refinery, a new unit with a capacity of 1100 B/SD of liquefied propane gas. Construction of this unit, designed and built by Sinclair personnel, was started July 1, 1949, and since going on stream it has been operating continuously. Currently it is producing an extremely dry, low olefinic content LPG product which meets all NGAA specifications for commercial propane. A flow diagram of the LPG unit is shown above.

This operation was undertaken to meet the ever increasing demand for liquefied petroleum gas in the North Atlantic seaboard area. Heretofore shipments of LPG to this market were made from the Mid-Continent area, but this proved to be economically unsound due to high freight rates and delays in transportation. Hence it was decided that a source of supply nearer to points of consumption was necessary.

The butanes and lighter hydrocarbons recovered from cracked distillate stabilization operations are treated in sequence with diethanolamine and caustic solutions for the removal of hydrogen sulfide and mercaptans. This hydrocarbon stream is then subjected to a high pressure (1000 psig) catalytic polymerization operation wherein 85%-90% of the propylene-butylene content is reacted. In the separate LPG unit the propane and lighter hydrocarbons stream from the refinery polymer de-propanizer are charged via gas driven reciprocating compressors to a 20-tray de-ethanizer which fractionates out 85%-90% of the propylene-propane content of the charge for LPG sales. The composition of feed, overhead and bottom streams of the de-ethanizer operations are as shown in Table 1.

A 126 ton/day capacity steam jet refrigeration unit is used during the warmer months to provide 50° F. cooling water for the reflux condenser of the de-ethanizer. A stuffing-boxless type centrifugal pump has given trouble-free operation in this rather difficult de-ethanizer reflux service. In order to prevent "frosting" of the overhead release gas pressure control valve and the downstream line from it, an all-welded shell and tube steam heater was installed between the gas outlet from the reflux accumulator and this gas release valve. LPG, the bottoms product of the de-ethanizer column, flows on level control from a cooler through an activated alumina drying tower and thence into "bullet-type" storage vessels. Three such vessels of 600-bbl. capacity each have been provided along with tank car and truck loading facilities.

Regeneration of the alumina is accomplished by stripping the adsorbed water from the drying beds with 350° F. propane vapors. A closed system is employed for regeneration of the alumina beds and consists essentially of a propane accumulator, a small centrifugal circulating pump, a vaporizer in which 550 psig. steam is used for vaporization and superheating, and a water cooled exchanger to condense the propane and water vapor effluent from the drying bed. The water desorbed from the drying bed separates out in the accumulator and is withdrawn from a well at the bottom of the accumulator. The towers are currently on a 24-hour drying cycle with regeneration now being accomplished in 6-12 hours.

TABLE 1—Composition of Feed, Overhead and Bottom Streams from De-ethanizer

	Feed Mol. %	Release Gas, Mol. %	LPG Liq. %
Methane	4.6	10.2	....
Ethylene	4.7	10.5	....
Ethane	20.9	65.5	0.5
Propylene	4.6	2.0	4.0
Propane	56.2	11.8	95.5
	100.0	100.0	100.0

CRUDE OIL ANALYSIS equipment at the Bureau of Mines laboratory at Laramie, Wyo.

Refining Properties Of New Crudes

Part 3—Oils from 20 New Discoveries in the Rocky Mountain Region Analyzed

By JOHN S. BALL, W. J. WENGER and M. L. WHISMAN
*Bureau of Mines Experiment Station, Laramie, Wyo.**

Twenty crude oils in the Rocky Mountain fields have been selected as representative of discoveries of the past two years in this territory. They have been analyzed by the special Bureau of Mines technique to indicate their refining potentialities. The analyses are compared with those of crudes from older fields in this area, both as to characteristics and as to possible utilization in processing.

DURING 1949, 17 new oil fields and 9 new producing zones in older fields were discovered in the Rocky Mountain region.[1] This discovery rate is similar to that in the previous two years (18 new fields in 1948 and 15 in 1947) but it is considerably higher than for several preceding years.[2] These figures reflect the increased effort which has gone into the search for oil in this area. The character of the oil thus found is of interest and importance to many refiners.

Previous articles in this series[4] have described the Bureau of Mines crude-oil analysis methods at the Bartlesville laboratories and have indicated their application to the evaluation of the potentialities of certain crude oils. Crude oils are analyzed at the Laramie laboratories in exactly the same way, except that is is necessary, because of the high altitude, to perform the initial distillation under pressure designed to simulate sea-level conditions[3].

Twenty crude oils have been selected as representative of the discoveries of 1948 and 1949 in the Rocky Mountain region. Twelve of these are from new pools while eight are from new producing horizons in old fields. The sources and characteristics of these oils are given in Table 1. The location of the fields from which they were produced is shown in Fig. 1.

The oils are found in formations ranging from Eocene to Cambrian in age. A notable fact is that 6 of the 20 oils come from depths greater than 8,000 feet. Significantly, of these 20 oils from what is usually considered a high-sulfur area, only 3 have sulfur contents greater than 1%, and 5 have less than 0.1% sulfur. The oils range in gravity from the condensate liquid of the Dove Creek field to the 20° API oil found in the Bowes field.

Description of Crudes

The crude oils will be described by state of origin, with comparison of their properties to those of oils from nearby fields.

Colorado: Two oils from Colorado fields are listed. The first is a condensate from the Dove Creek field, in the San Juan Basin of Colorado, New Mexico, and Utah. The oil contains almost 80% of gasoline boiling below 392° F. The sulfur content is low, and the oil quite paraffinic. The Correlation Index (defined in the first article of this series) reaches a maximum of only 18 (for fraction 5), and the cloud temperature for the 3 vacuum fractions increases from 20° to 60° F. The properties of the oil are quite similar to those of other oils produced in this basin, as indicated in Table 2.

The Oak Creek crude oil resembles rather closely the oil produced from the Tow Creek field, which is approximately 15 miles north of the Oak Creek field. It is also similar to oils from the Moffat and Iles fields about the same distance to the west. Table 3 indicates the similarity, which is pronounced even among oils from different formations. All these oils are paraffinic as shown both by Correlation Indexes and by cloud tests on the fractions.

Montana: Montana is represented by four oils from the Bowes, Cut Bank, Sumatra, and Woman's Pocket fields. Two of these fields are new, but the Madison limestone is a new producing zone at Cut Bank, and the Ellis is a new producing zone at Bowes.

The oil from the Bowes field is a heavy oil of 19.8° A.P.I. gravity containing 3.75% sulfur. It has a low gasoline content and 45% residuum remains after the Bureau of Mines distillation. The sulfur content is probably the highest of the Montana oils. There are few comparable fields in Montana. However, in Wyoming, Jurassic formation oils are of two widely different types; the low-sulfur crude oil, as at Lance Creek, and the high-sulfur oil. Examples of this latter type of oil are found in the Poison Spider, Bolton Creek, Spindletop, and Steamboat Butte fields of Wyoming. The Bowes oil compares quite closely with these high-sulfur Wyoming oils.

The Madison limestone (Mississippian) production from Cut Bank is quite similar to the production from the same formation at the Pondera field or from Elk Basin. However, because of its low carbon residue, it probably will not produce as much asphalt.

The two new fields, Sumatra and Woman's Pocket, are on either side of the Gage field in south central Montana. All three fields produce from the Amsden formation. The oil from Woman's Pocket, however, is considerably higher in sulfur content; and, based on carbon residue, its yield of asphalt would be greater. Properties of the various Montana crude oils are compared in Table 4.

Nebraska: Although Nebraska is not a Rocky Mountain State, the

* John S. Ball is a Refinery Engineer and W. J. Wenger and M. L. Whisman are Chemists, at the Bureau of Mines Petroleum and Oil Shale Experiment Station, Laramie, Wyo.

Gurley field in western Nebraska is on the rim of the Denver Basin, which extends west to the mountains. The oil produced is a waxy, 35-gravity oil, with low (0.23%) sulfur. Its pour point is 50° F.

As the oil from the Borie (Wyo.) field comes from the same basin and from a formation of the same age, it should be considered at the same time. Table 5 shows the great similarities of the oils produced from Cretaceous formations in the Denver basin.

Utah: Two crude-oil samples from Utah are included. Both are from the Uintah Basin. The Ashley Valley sample is from a newly discovered producing formation, the Weber sandstone (Pennsylvanian). This is the same formation that furnishes the major part of the production from the nearby Rangely (Colorado) field. These oils are similar, except that the Ashley Valley is slightly heavier (30.8° A.P.I. as compared with 34.6° for Rangely). There is a corresponding increase in sulfur (0.83% as against 0.66) and residuum (31.3% vs. 23.0).

The oil from Roosevelt field is a quite waxy, greenish-black oil, with sulfur lower than 0.1%. It is from the Green River shale (Eocene). A somewhat similar oil is produced from the Mancos shale (Cretaceous) of the Rangely field. However, the Roosevelt oil is heavier (30.0° A.P.I. compared with 40.4°), waxier, and contains a greater percentage of residuum.

Wyoming: A general description of the crude oils of Wyoming has been published[2] which includes a number of the recent discoveries. However, 11 oils are discussed in this article to include the most recent developments there. One of the Wyoming fields, Borie, was described with the Nebraska oil because of its relationship to that oil.

Sussex is one of the most active areas in Wyoming development. This field was opened with the discovery of oil from the Lakota sandstone (Cretaceous). Since that time, three other productive zones have been found, all within the Cretaceous, and discoveries at Meadow Creek and North Meadow Creek may tie in with the original field. The analysis of the Lakota oil is shown as Table 6, and comparisons with other oils are given in Table 7.

Not far from Sussex and also producing from Cretaceous formations are the South Cole Creek and Glenrock fields. These oils are all similar, as shown in Table 7, and like the older fields of the vicinity, such as Big Muddy and Cole Creek.

The deepest producing field in Wyoming produces from some of the youngest formations. The West Poison Spider field, which produces from the Frontier formation at 14,308 ft., was found to be productive in the

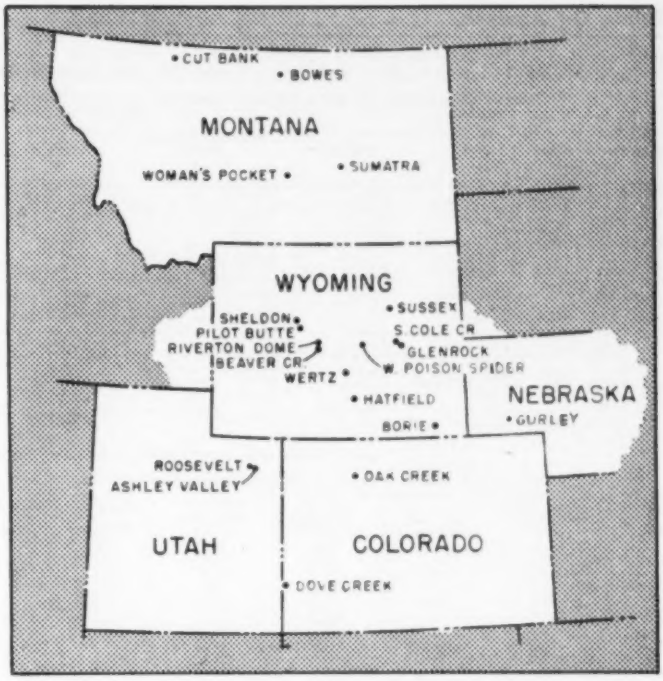


FIG. 1—Location of some recently discovered oil fields of the Rocky Mountain region

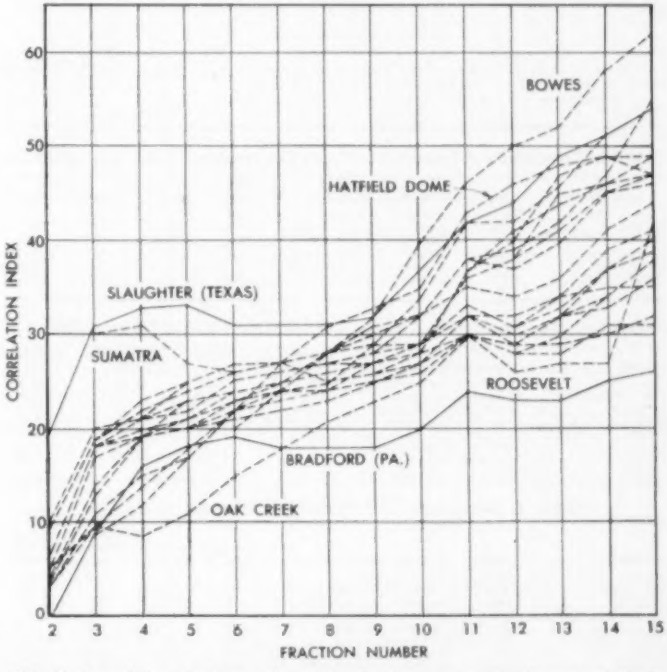


FIG. 2—Correlation Indexes of crude oils from recently discovered Rocky Mountain fields

TABLE 1—Summary of Information on Crude Oils from Recently Discovered Rocky Mountain Fields

PART 1—SUMMARY OF DATA SHOWING SOURCES AND GENERAL CHARACTERISTICS OF SAMPLES

Item	Sample	State	Field	County	Producing formation and age	Depth, ft.	Gravity, °A.P.I.	Color*	Sulfur, %	Viscosity 100° F., secs.	Carbon residue, %
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
1	49-76	Colo.	Dove Creek	Montezuma	Paradox, Penn.	5,900-5,978	63.4	W W	<0.10	<32	0.0
2	49-253	Colo.	Oak Creek	Routt	Morrison, Cret.	6,640	38.0	br-bl	0.23	46	2.6
3	50-284	Mont.	Bowes	Blaine	Ellis, Jur.	3,360-3,385	19.8	br-bl	3.75	660	10.6
4	50-297	Mont.	Cut Bank	Glacier	Madison, Miss.	3,244-3,247	37.3	br-gr	0.80	39	1.3
5	50-283	Mont.	Sumatra	Rosebud	Amsden, Penn.	4,385-4,415	29.5	br-bl	0.65	72	4.0
6	50-288	Mont.	Woman's Pocket	Golden Valley	Amsden, Penn.	2,110	20.5	br-bl	2.52	420	9.3
7	50-174	Nebr.	Gurley	Cheyenne	Dakota (1st Bench), Cret.	4,410-4,425	35.6	gr-bl	0.23	54	2.0
8	50-341	Utah	Ashley Valley	Uintah	Weber, Penn.	4,181-4,308	30.8	br-bl	0.83	61	4.5
9	50-337	Utah	Roosevelt	Uintah	Basal Green River, Eoc.	9,350-9,390	30.0	[illegible]	<0.10	[illegible]	2.2
10	49-93	Wyo.	Beaver Creek	Fremont	Tensleep, Penn.	10,442-10,903	44.3	br-gr	0.58	32	0.7
11	50-176	Wyo.	Borie	Laramie	Muddy, Cret.	8,494	37.2	br-gr	0.24	42	1.5
12	50-110	Wyo.	Glenrock	Converse	Muddy, Cret.	7,202-7,226	40.4	[illegible]	<0.10	2	1.0
13	49-48	Wyo.	Hatfield	Carbon	Nugget (Sundance), Jur.	4,351-4,420	34.4	br-gr	0.72	42	1.9
14	49-94	Wyo.	Pilot Butte	Fremont	Muddy, Cret.	3,533-3600	46.5	[illegible]	<0.10	35	0.3
15	49-116	Wyo.	Riverton Dome	Fremont	Tensleep, Penn.	11,665-11,884	40.8	NPA 8	0.83	33	0.6
16	49-191	Wyo.	Sheldon	Fremont	Tensleep, Penn.	6,764-7,068	34.6	br	1.08	42	2.5
17	50-113	Wyo.	South Cole Creek	Converse	Lakota, Cret.	8,285-8,324	34.6	gr-bl	0.17	48	2.8
18	50-279	Wyo.	Sussex	Johnson	Shannon, Cret.	4,537-4,562	40.2	br-gr	0.14	38	1.0
19	50-77	Wyo.	Wertz	Sweetwater	Cambrian, Camb.	7,150-7,630	33.6	br-bl	1.39	42	2.9
20	50-352	Wyo.	West Poison Spider	Natrona	Mesa Verde, Cret.	9,230-9,288	42.8	br-gr	<0.10	35	0.4

Part 2—SUMMARY OF ANALYTICAL AND COMPUTED DATA

Item	Volume percentages — Fractions — 1-3, inc. (light gasoline)	4-7, inc. (naphtha)	8-12, inc. (kerosine and gas oil**)	13-15, inc. (lubricating oil**)	Residuum	Correlation index averages of fractions 4-7, inc.	13-15, inc.	Characteristics of residuum — Percentage on gasoline-free basis	Specific gravity
	(12)	(13)	(14)	(15)	(16)	(17)	(18)	(19)	(20)
1	37.9	41.3	16.3	1.4	0.3	16	...	1	0.867
2	4.1	18.0	33.3	21.8	22.0	13	30	28	.937
3	5.9	9.6	20.9	18.0	44.9	21	57	53	1.040
4	10.8	22.0	29.0	17.2	19.8	24	44	29	.953
5	5.4	10.8	28.7	21.5	32.5	28	40	39	.970
6	0.0	4.9	25.4	25.4	44.0	22	48	46	1.015
7	8.1	18.3	24.5	18.0	29.8	22	34	40	.955
8	5.5	16.8	27.1	18.3	31.3	22	44	40	.983
9	2.7	11.9	18.7	21.6	44.6	22	32	52	.941
10	12.3	29.8	32.6	13.8	7.5	23	46	13	.862
11	9.7	19.7	25.0	18.5	25.3	25	36	36	.905
12	10.1	21.6	23.9	16.3	24.9	24	34	36	.925
13	5.0	19.0	35.4	20.8	19.1	20	47	25	.956
14	15.4	27.9	28.3	14.0	11.7	21	39	21	.915
15	3.3	39.8	38.0	12.8	6.1	26	48	11	.865
16	5.4	18.0	30.1	19.1	24.0	19	46	31	.960
17	7.8	18.1	25.4	18.0	29.8	23	35	40	.958
18	11.3	22.2	28.3	16.3	20.0	21	38	30	.943
19	6.9	20.4	30.9	18.2	22.5	19	50	31	.981
20	11.7	28.1	27.2	15.8	14.7	24	36	24	.932

* Color of crude oils is designed by following abbreviations: W W, water white; br-bl, brownish-black; br-gr, brownish-green; gr-bl, greenish black; br, brown; NPA 8, by ASTM test D153-45T.

** Approximate.

TABLE 2—Comparison of Properties of Crude Oils Produced in the San Juan Basin

Field	State	Formation—Age	Sulfur, %	Gravity °A.P.I.	Gasoline %	Gasoline Gravity
Dove Creek	Colo.	Paradox—Pennsylvanian	<0.1	63.4	79.2	68.1
Chromo	Colo.	Mancos—U. Cretaceous	0.16	31.5	6.1	54.7
Hogback	N.M.	Dakota—U. Cretaceous	<0.1	60.2	70.0	69.5
Rattlesnake	N.M.	Dakota—U. Cretaceous	<0.1	56.7	68.9	63.7
Table Mesa	N.M.	Dakota—U. Cretaceous	<0.1	58.2	61.7	68.8
Boundary Butte	Utah	Cutler—Pennsylvanian	0.11	42.5	38.7	58.9

TABLE 3—Comparison of Oak Creek Crude Oil With Oils from Neighboring Fields

Field	Formation—Age	Gravity, °A.P.I.	Sulfur, %	Pour Point °F.	Gasoline, %
Oak Creek	Morrison—Cretaceous	38.0	0.23	40	22.1
Tow Creek	Mancos—Cretaceous	34.6	.20	20	27.8
Moffat	Morrison—Cretaceous	40.2	.24	35	31.2
Moffat	Dakota—Cretaceous	37.8	<.1	35	29.8
Moffat	Sundance—Jurassic	36.6	.35	20	22.6
Iles	Morrison—Cretaceous	31.5	.58	<5	14.5
Iles	Sundance—Jurassic	31.5	.63	<5	17.2

TABLE 4—Comparison of Properties of Montana Crude Oils

Field	State	Formation—Age	Sulfur, %	Gravity, °A.P.I.	Residuum, %	Carbon Residue, Crude, %
Bowes	Mont.	Ellis—Jurassic	3.75	19.8	44.9	10.6
Cut Bank	Mont.	Madison—Mississippian	0.80	37.3	19.8	1.3
Sumatra	Mont.	Amsden—Pennsylvanian	0.65	29.5	32.5	4.0
Woman's Pocket	Mont.	Amsden—Pennsylvanian	2.52	20.5	44.0	9.3
Lance Creek	Wyo.	Sundance—Jurassic	<0.1	49.4	8.8	0.4
Poison Spider	Wyo.	Sundance—Jurassic	3.13	19.5	43.8	10.3
Gage	Mont.	Amsden—Pennsylvanian	0.67	34.0	22.4	2.1
Ponders	Mont.	Madison—Mississippian	2.03	30.2	28.2	4.7
Elk Basin	Mont.	Madison—Mississippian	1.98	28.4	31.8	6.1
Oregon Basin	Wyo.	Madison—Mississippian	3.41	18.2	54.3	9.6

Mesa Verde formation (also Upper Cretaceous) at 9,288 ft. The two oils are quite similar, having gravities of 42.8° and 41.5° A.P.I., less than 0.1% of sulfur and almost identical yields of the various fractions.

The oldest formations from which oil is produced in Wyoming are of Cambrian age. Production from this zone has recently been accomplihsed in the Wertz field. The only other field having Cambrian production is the nearby Lost Soldier field. The oil from this formation very closely resembles oil from Madison, Amsden, and Tensleep formations (see Table 8). It is a high-sulfur, low-wax-content oil.

The Hatfield Dome production from the Sundance formation belongs in the high-sulfur classification, although the sulfur content is only 0.72%. As mentioned previously, two quite different types of oil are found in formations of this age. The Hatfield Dome production is thus quite different from the Lost Soldier production (see Table 8). This Sundance oil is somewhat heavier and higher in sulfur content than the previous production of the Hatfield Dome field,

which came from the deeper Tensleep formation.

Three of the remaining Wyoming oils are from the Tensleep formation, and in Table 9 they are compared with oils from the nearby Maverick Springs and Pilot Butte fields. A relationship is evident between the depth of the production zone and the asphaltic character of the oil.

The oil from the Muddy formation at Pilot Butte field is a low-sulfur, paraffinic oil containing 43% gasoline. It differs considerably from the oils produced at greater depths, which contain more sulfur and are heavier. It is rather similar to oils from the same formation in other fields.

Correlation Indexes

The Correlation Indexes as given in Table 1 are, in general, comparatively low, indicating the degree of paraffinicity of the Rocky Mountain crude oils. As indicated in the first paper of this series,[1] Bradford (Pa.) oil may be taken as an example of a paraffinic oil, while Slaughter (Texas) and Conroe (Texas) may be taken as aromatic oils. The Correlation Index values for Fractions 4-7 (Col. 17, Table 1) for these oils would be 21, 35, and 40, respectively. The highest value for the Rocky Mountain oils is 28 and most of them are 22 or below.

For the heavier fractions (Col. 18, Table 1), the Rocky Mountain crude oils vary from 30 to 57. This compares with Bradford oil at 28, Slaughter at 51 and Conroe at 38. Thus, the crude oils studied are more aromatic in the higher-boiling fractions. This is to be expected because of their asphaltic character. The sulfur content may also influence the value as sulfur compounds have high densities.

Fig. 2 shows the correlation-index patterns of the 20 Rocky Mountain crude oils, as compared with Bradford and Slaughter oils. In the low-boiling fractions, the Sumatra oil stands out as aromatic, while the Oak Creek oil is highly paraffinic. In the higher fractions, the Bowes and the Hatfield Dome oils show aromaticity while the Roosevelt oil shows paraffinicity. The pour point of the latter oil is 85° F.

Utilization

Based upon the principles set forth in earlier papers of this series and the analyses of the oils, certain predictions can be made concerning the utilization possibilities of these oils.

Aviation base stock: The only crude oil with a correlation index of 28 or above for Fraction 4 is that from the Sumatra field. This crude oil contains only a small percentage of gasoline, and the sulfur content of the gasoline is likely to be high so that base-stock preparation is not indicated.

Toluene: Again the Sumatra crude is the only one which might contain sufficient toluene to make recovery feasible.

Motor Gasoline: All of the crude oils contain gasoline in varying quantities. The low correlation index indicates that the octane number of the straight-run gasoline would be low, necessitating blending with cracked gasoline. Some of the crude

TABLE 5—Comparison of Crude Oils from Denver Basin

Field	State	Formation—Age	Sulfur, %	Gravity, °A.P.I.	Pour Point, ° F.	Gasoline, %	Residuum, %
Gurley	Neb.	Dakota—Cretaceous	0.23	35.6	50	26.4	29.8
Borie	Wyo.	Muddy—Cretaceous	0.24	37.2	55	29.4	25.3
Horse Creek	Wyo.	Lakota—Cretaceous	3.35	30.2	55	15.5	29.4
Fort Collins	Colo.	Dakota—Cretaceous	0.18	31.9	55	18.1	28.2
Fort Collins	Colo.	Muddy—Cretaceous	0.13	35.2	45	29.4	24.2

TABLE 6—Report of Crude Petroleum Analysis for Sussex Crude Oil

Identification	General Characteristics	
Sample PC-48-30	Sp. Gr.	0.829
Sussex field	API Gr.	39.2°
Lakota sandstone	Sulfur %	0.35
7,698-7,726 ft.	Pour point, ° F.	30
Johnson County, Wyo.	Color	brownish-black
	Viscosity, S.U.S. @ 100° F.	40

Distillation, Bureau of Mines Routine Method

STAGE 1—Distillation at standard pressure, 760 mm. Hg absolute first drop, 29° C. (84° F.)

Fraction No.	Cut at ° C.	Cut at ° F.	%	Sum, %	Sp. Gr., 60/60° F.	°A.P.I., 60° F.	C.I.	Aniline Point, ° C.	S.U. Visc., 100° F.	Cloud Test, ° F.
1	50	122	2.3	2.3	0.662	82.2		.....	.....	.....
2	75	167	2.3	4.6	.663	81.9	4.2	.....	.....	.....
3	100	212	4.0	8.6	.704	69.5	14	.....	.....	.....
4	125	257	6.7	15.3	.735	61.0	19	.....	.....	.....
5	150	302	5.6	20.9	.755	55.9	21	.....	.....	.....
6	175	347	4.9	25.8	.773	51.5	23	.....	.....	.....
7	200	392	4.5	30.3	.787	48.3	23	.....	.....	.....
8	225	437	4.9	35.2	.801	45.1	24	62.2	.....	.....
9	250	482	6.4	41.6	.817	41.7	27	66.6	.....	.....
10	275	527	5.6	47.2	.831	38.8	29	70.2	.....	.....
STAGE 2—Distillation continued at 40 mm. Hg absolute										
11	200	392	3.1	50.3	0.846	35.8	32	76.6	41	25
12	225	437	6.2	56.5	.852	34.6	31	.....	45	40
13	250	482	5.3	61.8	.862	32.6	32	.....	55	60
14	275	527	5.0	66.8	.873	30.6	34	.....	73	75
15	300	572	6.4	73.2	.887	28.0	38	.....	120	90
Residuum			23.7	96.9	.943	18.5	.....	.....	.....	.....

Carbon residue of residuum, 6.5%; carbon residue of crude, 1.7%.

Approximate Summary

	%	Sp. Gr.	°A.P.I.	Viscosity
Light gasoline	8.6	0.682	76.0	.....
Total gasoline and naphtha	30.3	.737	60.5	.....
Kerosine distillate	11.3	.810	43.2	.....
Gas oil	14.5	.843	36.3	.....
Nonviscous lubricating distillate	11.5	.857–.881	33.6–29.1	50–100
Medium lubricating distillate	5.6	.881–.895	29.1–26.6	100–200
Viscous lubricating distillate	.9	.....	.....	>200
Residuum	23.7	.943	18.5	.....
Distillation loss	3.1	.....	.....	.....

TABLE 7—Comparison of Sussex Oils With Those of Nearby Fields

Field	Formation—Age	Gravity, °A.P.I.	Sulfur, %	Pour Point, ° F.	Gasoline, %	Residuum, %
Sussex	Lakota—Cretaceous	39.2	0.35	30	30.3	23.7
Sussex	Shannon—Cretaceous	40.2	0.14	10	33.5	20.0
South Cole Creek	Lakota—Cretaceous	34.6	0.17	45	25.9	29.8
Glenrock	Muddy—Cretaceous	40.4	<0.1	55	31.7	24.9
Cole Creek	Lakota—Cretaceous	35.0	0.19	45	27.9	28.4
Big Muddy	Lakota—Cretaceous	34.3	0.15	55	22.2	32.5
Big Muddy	Muddy—Cretaceous	33.6	0.26	45	23.1	28.3

TABLE 8—Comparison of Oils from Different Formations at Wertz and Lost Soldier Fields

	Gravity, °A.P.I.	Sulfur, Percent	Carbon Residue, Percent	Gasoline, Percent	Residuum, Percent
		Wertz Field			
Cambrian	33.6	1.39	2.9	27.3	22.5
Madison	35.0	1.34	2.8	28.5	22.6
Amsden	35.0	1.25	2.6	28.2	23.2
Tensleep	35.3	1.26	2.3	32.4	23.4
		Lost Soldier Field			
Cambrian	34.6	1.27	3.3	28.5	24.7
Madison	35.6	1.22	3.0	28.6	24.1
Tensleep	34.2	1.23	3.2	30.2	23.3
Sundance	29.5	0.10	1.9	11.4	27.3

TABLE 9—Comparison of Oils from Tensleep Formation—Pennsylvania Age

	Depth, Ft.	Gravity, °A.P.I.	Sulfur, %	Carbon Residue, %	Residuum, %
Beaver Creek	10,442	44.3	0.58	0.7	7.5
Riverton Dome	11,665	40.8	.83	0.6	6.1
Sheldon	6,764	35.0	1.16	2.4	21.6
Maverick Springs	1,650	21.8	2.88	7.3	43.5
Pilot Butte	6,159	24.5	2.68	7.3	38.5

oils would make gasoline having excessive sulfur contents which would have to be removed.

Solvent Naphthas: Because of their low C.I. values many of the oils should be suitable for the manufacture of aliphatic solvents.

Kerosine: The absence of aromatic compounds, as indicated by the low C.I., should make most of these oils suitable for kerosine manufacture.

Diesel Fuels: The presence of paraffin wax and the consequent effect on the pour point is likely to be the limiting consideration in making Diesel fuels from these oils. However, it is noticeable that the correlation index curves for some of the oils (Fig. 2) show rapidly increasing aromaticity in this boiling range. This indicates the presence of aromatics which will have an adverse effect on the cetane number.

Fuel Oil: All of the crude oils can be used for the manufacture of fuel oil. However, for Grades 1, 2, and 4 (ASTM D396) the pour-point specification will limit the amount that can be made.

Jet-Engine Fuel: Again, the freezing-point specification will probably be the limiting feature because of the paraffinicity of the crude oils.

Lubricating Oil: None of the oils appear to be well-suited to the manufacture of lubricating oils. All would require dewaxing, and most have an asphaltic character that would make processing difficult.

Asphalt: Many of the oils would make appreciable quantities of asphalt. Using the relationship, carbon residue times 4.9 gives per cent of 100-penetration asphalt, the Bowes and Woman's Pocket oils would contain more than 45% asphalt. The Sumatra and Ashley Valley oils would contain in the neighborhood of 20%, and various other oils would contain smaller amounts. Based on a comparison with Rangely crude a yield of 10-15% from Ashley Valley crude oil would be more nearly correct. However, in general the correlation gives reasonable results.

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High-Additive Oils Rated In "Gas" Engine Service

TESTS in the field with passenger cars and light gasoline trucks in certain types of operations show improved conditions with regard to engine wear and deposits through the use of the new type high-additive oils, known as Supplemental 1 and 2 and Series 2 oils. The improvement is most marked where the fuels used are of higher deposit-forming characteristics than are found in the average motor gasolines used today.

Field service data to this effect and laboratory test results were reported by several oil companies at the Symposium on High Additive Content engine oils sponsored by ASTM Committee D-2 on Petroleum Products and Lubricants, held at San Francisco last Oct. 12. The various papers and discussions given there have only recently been made public. First developed for use in Diesel engines,[1] the new type oils appear now to have general acceptance in this field for heavy-duty service particularly. Hence later studies by the oil companies and others have been to determine their economic application in gasoline engines.

Accepted by Armed Services

The high-additive oils have already been accepted by the Armed Services for heavy-duty service in gasoline engines in ground equipment as well as in Diesel engines, and they are included in the new Military Specification 2104.[2, 7] Logistically, it is necessary that, for military purposes, a single-type oil be specified which will satisfy the requirements of both types of engines in Army and Navy usage.

The new lubricants differ from the previous heavy-duty engine oils in that they contain from 5 to 10 times as much additive. The additive is principally an organic metal compound of high detergent properties. This relatively high use of additive is exemplified by ash values of above 2% for some of the oils.

The test work on the performance of the new oils in gasoline engines has been principally in passenger cars and light trucks in stop-and-go service in urban areas where trips are short and stops frequent. With both types of vehicles sludging problems occur, especially with fuels of higher deposit forming tendencies. Some conclusions on this test work, as reported at the Symposium are:

"With respect to gasoline operation, the data to date indicates the same relative improvement from the standpoint of deposit and wear as in Diesel engines," said Bassett.[3] "It will be necessary to accumulate additional service experience in gasoline engines before the use of such products can be recommended for all engines under all operating conditions".

"Based on the laboratory experience of the industry as a whole, and service data available to date, the use of higher quality lubricating oils such as Supplement 1 and 2 oils has been justified in commercial operation and will continue as these oils become more widely used".

"Light truck and passenger car field tests, carried out under rigidly controlled conditions, show that a significant reduction in sludge and ring zone deposits can be obtained by the use of low or moderate concentrations of detergent-type additives", said Boehm and Tongberg.[4]

"However, in light truck field tests, a high detergency motor oil showed no advantage over a high quality, heavy-duty oil of lower additive content and detergency level. It should not be assumed, therefore, that high additive concentrations or high levels of detergency *per se*, are a guarantee of outstanding performance under all service conditions".

"Work in the gasoline engine field to date has indicated that the Special heavy-duty oil performs at least as well as other types of lubricant", said Edgar and Jeffrey.[5] Definite advantage can be obtained as to engine cleanliness with the new oil. Excessive combustion chamber deposits leading to rapid increase in octane requirement and to short spark plug life have not developed. Exhaust valve deposits have been observed but there is no clear record that they adversely affect valve life.

Not Necessary-But Helpful

"Our conclusions are at this time that, while gasoline engines do not require an oil of this type, some advantage may accrue to its use in certain types of service and there seem to be no limiting factors".

The possible effect on the octane requirements of gasoline engines of the high ash, or additive content, of Series 2 oils was studied by Bassett.[3] Two 1949 Oldsmobile, Series 98 cars, using the 7.25:1 compression ratio Rocket engine, were used to investigate this factor and were operated under similar conditions for approximately 8000 miles.

One engine was lubricated with a

premium type motor oil which contained an oxidation inhibitor only, while a Series 2 oil with the same base stock was used in the second car. The fuel used was normally a 100% cracked stock containing 2.0 to 2.5 ml. TEL per gal.

Uncorrected octane requirements, using primary reference fuels, was as follows:

Miles of Operation	Oil A (prem.)	Oil B (Series 2)
0	75	73
1500	78	80
4500	82.5	80
8000	85	83

After 8000 miles the engines were disassembled. Combustion chamber deposits with the premium oil weighed 73.25 g., and with the Series 2 oil 69.85 g. Other investigators have shown, it was stated, that a paraffinic type of base stock such as was used in this test would result in an increase of about 8 points in octane requirements at 8000 miles. It would therefore appear that the premium and Series 2 treatments have little effect on this factor.

"Our experience based upon some 10,000,000 miles of actual experience in a wide variety of gasoline equipment run on the Pacific Coast during the past year," said Grunder[6] showed that no 2-104B oil has come even close to matching a Supplemental List 1 oil, which also qualifies as a Preservative Engine Oil, U. S. Army Spec. No. 2-126. By matching I mean engine-owner satisfaction based upon engine life, overhaul costs, operating costs, continuity in service and continued high level of power output.

"Door-to-door delivery service infers crankcase temperatures during operation which are unable to reach the heat levels commensurate with cooling system temperatures. It also infers that stand-by time is about as long as route time. Since moisture and sludge are among the main problems of low heat level engine operation, rust and corrosion problems will also be prevalent, which present serious threats to engine life."

Laboratory Work

Some laboratory studies of the effect of the high additive oils in overcoming the deposits formed in gasoline engines in stop-and-go service were reported at the Symposium, mainly through the Coordinating Research Council FL-2 procedure. Operating conditions are 45 bhp. at 2500 rpm., with water inlet temperature at 85° F., water outlet at 95° F. and oil sump temperature of 150° F. These conditions in effect result in high specific fuel consumption at low block and sump temperatures, which artificially reproduces stop-and-go service conditions.

Bassett[3] reported on studies with the FL-2 test, and also with the CRC L-4 engine test under special cycling conditions to reproduce the type of engine deposits commonly found in passenger car and light-duty truck service.

In all these tests, particular attention was directed to valve condition, combustion chamber deposits, ring wear and oil consumption. In no instance was it found that Series 2 oils adversely affected valve conditions or combustion chamber deposits. Valve stems were reported as particularly clean and no appreciable buildup was found under the valve heads. There was no evidence of face or seat deposits differing from those normally found with 2-104B lubricants.

A system of running low temperature, FL-2 laboratory engine tests on experimental oils based on the use of a standard lubricating oil and fuel combination was presented by Boehm and Tongberg.[4] It was shown that ring-zone and sludge deposits in FL-2 tests carried out under rigidly controlled conditions in the laboratory with oils of different compositions can be correlated with field results from low-temperature service tests.

"However", it was stated, "the low absolute level of both ring-zone and sludge deposits in the FL-2 tests constitute a serious weakness of this test for guiding the development of improved products. Further work is necessary to develop a laboratory engine test technique which will be useful for predicting the field performance of lubricating oils under low-temperature engine operating conditions".

Military Adopts Them

Oils of the future for use by the Armed Services in ground equipment will be obtained in the quality range between 2-104B and Supplemental List 1 oils, N. L. Klein, Chief of the Fuels and Lubricants Section, Ordnance Research and Development Division Office, Chief of Ordnance, Washington, told the Symposium.[7]

"The future military engine oils must perform satisfactorily in both gasoline and diesel engines under all conditions of operation," said Mr. Klein. "They must assure trouble-free operation when using fuels of the future, particularly the high-sulfur diesel fuels which appear to be a certainty. They must be capable of extended use in the crankcase without deleterious effect to the engine. They may have to withstand the high operating temperatures which will be experienced in air-cooled combat vehicle engines operating without oil coolers."

The trend in military gasoline engine design, he stated, is toward high output units of light weight and small over-all dimensions. A complete line of air-cooled engines is under development for use in tanks and other combat vehicles, and may be used for transport vehicles as well. Silver bearings are coming into general use in these engines. Higher operating oil temperatures must be taken into consideration. Higher output liquid-cooled engines will be used for a variety of applications in trucks, pipeline pumping service, in engine generator units and so on. The trend in Army diesel engine design is along the same lines with supercharged units a definite possibility, it was said.

No improvement in the quality of fuels maintained during the recent World War is to be expected in the immediate future Mr. Klein said. Present military gasoline engines are being designed to operate on 80-octane fuel. However, a decrease in fuel quality insofar as engine wear and cleanliness is concerned is anticipated in the event of a future emergency, when the impact of the aviation gasoline and jet fuel requirements will be felt. Fuels of higher sulfur content, particularly diesel fuels, are already in evidence and are anticipated in much greater quantity in the event of war.

A partial list of properties of future military engine oils was given, in consideration of the trends in engine design, fuel quality and operating conditions, as follows:

1—Freedom from deposit formation tendencies which would cause increase of engine octane requirement, spark plug fouling and valve burning.

2—Freedom from varnish and sludging.

3—The ability to decrease engine wear in light or intermediate service and in high-output engines.

4—Good load-carrying properties.

5—Minimum corrosive action on silver and copper bearings.

6—Stability at high engine operating temperatures.

7—Freedom from ring sticking.

8—Low oil consumption rate.

9—Stable low pour point.

10—Ability to permit easy engine cranking at low temperatures.

Brief reviews of some of the tests of the new oils in gasoline engines presented at the Symposium are given below:

Tests in Heavy-Duty Trucking And in Light Truck Service

TWO series of field tests were reported by Bassett[3] covering the use of Series 2 oils in gasoline engines in heavy-duty trucking service and in intermediate-duty light truck service. The purpose was to determine what adverse effects might be encountered, even though a comparable improvement would be obtained from the standpoint of engine

TABLE 1—Typical Inspection Data at Completion of Three Mountain Tests, Using Untreated Solvent Extracted Mid-Continent SAE 30 Oil and Same Base Oil Treated to 2-104B and Series 2 Quality

Engine Condition	Untreated Base Oil	2-104B Oil	Series 2 Oil
Varnish Deposits			
Piston skirts	5.0	7.0	10.0
Crankcase oil pan	2.0	2.0	9.0
Valve spring cover	5.0	6.0	10.0
Valve stems, intake	6.0	7.0	9.5
Valve stems, exhaust	6.0	7.0	10.0
Varnish total	24.0	29.0	48.5
Sludge and carboneous deposits			
Piston ring grooves	5.0	7.0	9.0
Oil ring drain slots	8.0	10.0	10.0
Oil suction screen	9.0	10.0	10.0
Valve spring cover	6.5	8.0	9.5
Crankcase oil pan	8.0	8.5	10.0
Sludge total	36.5	43.5	48.5
Combined rating	60.5	72.5	97.0
Drain analysis			
Conradson carbon % by wt.	1.12	1.58	5.20
Viscosity increase %	36.4	13.3	16.4
Neutralization number	1.32	1.20	1.41

cleanliness and reduced wear.

The first test was in a fleet of four Dodge 1½-ton tractor-trailer units on a 65-mile course between Hagerstown and Cumberland, Md. The units were loaded with concrete blocks, 22,500 lbs. gross weight, with engine speed held by shifting gears as closely as possible to 3000 rpm. Each test was of 6000 miles duration, without oil change in order to accelerate deposit buildup. Lubricant temperatures were in the range of 210-265° F., with an average of about 235° F. for the entire test. The fuel used was a commercial regular grade gasoline containing 1.2 ml. TEL per gal.

Table 1 shows typical inspection data at the completion of three tests using untreated base oil and the same base stock treated to 2-104B and Series 2 quality. In this test there was relatively little idling or low engine speed operation which it was said probably accounted for the relatively good sludge condition regardless of lubricant. The cleanliness data were reported about what might be expected. The wear data was not regarded sufficiently complete to permit any definite conclusions. There was some indication that deposits under the intake valve heads were heavier with the Series 2 lubricant, but this was not reflected on the valve faces or seats and their appeared to be little effect on exhaust valve burning.

The investigation of the Series 2 oils in gasoline engines in intermediate duty, light truck service was made in a fleet of 1½-ton Chevrolet trucks operating in western Pennsylvania in the delivery of bakery goods. The normal routing was to stop in adjacent towns during the day, making several deliveries in each location. These tests were of 6000 miles duration and were run without oil change to accelerate deposit formation. Fuel used was a regular grade gasoline containing approximately 2 ml. TEL per gal. Table 2 shows comparative data from a series of tests on untreated base oil and the same base stock treated to 2-104B and Series 2 quality.

Light Trucks in Stop-and-Go Service Tested for Sludging

A SERIES of field tests in light trucks, to determine the extent of reduction in sludge and ring zone deposits to be obtained by the use of low or moderate concentrations of detergent-type additives in the engine oil, was reported by Boehm and Tongberg[4]. The tests were in a fleet of light trucks equipped with engines of a widely used make. The operations were typical of door-to-door delivery service where low engine temperatures are encountered and where severe sludging had been encountered by the fleet in the past.

In the first phase of this program, the basic effect of oil composition on deposit formation was studied by operating the vehicles on oils of different compositions, using a special fuel of minimum deposit-forming characteristics. In the second phase the ability of oils to handle fuel decomposition products was studied by using a specially prepared high deposit fuel.

In this fleet field test program about four vehicles were used in each oil-fuel combination in order to minimize the variations in individual units. New engines were installed in the vehicles at the start of the test, complete measurements being made to assure that each engine met the manufacturer's specified tolerances. The vehicles were operated on a 4000-mile drain period with no filters in order to accelerate the accumulation of deposits. The thermostats were set for 160° F. and no adjustments were made in the normal cooling system or crankcase ventilation.

In the tests with the minimum deposit-forming fuel, three oils were studied. Two were high viscosity index, well-refined straight mineral oils of SAE 30 grade made from different crudes, with no added oxidation inhibitors or detergents. The third was a high viscosity index, high quality SAE 30 heavy-duty oil, containing 4.4% of additive, the oil representing the top level of performance quality of oils approved under U. S. Army Specification 2-104B.

All the units operated in this phase of the program gave uniformly low sludge and ring zone deposits. The level of deposits obtained was independent of the lubricant used over the period of 12,000 miles. The piston skirt varnish deposits were moderately high, in the same range for all oils, and apparently not a function of the composition of the particular oils examined. It was concluded that oils of the quality level and range represented apparently do not deteriorate in this type of service to give any significant degree of engine deposits during the test period.

In the second phase of the light truck field test program, a fuel of high deposit-forming characteristics was used and 3 oils of different composition were employed. The first was a well-refined, high viscosity in-

TABLE 2—Comparison of Engine Conditions from Intermediate Duty Service Test Results, Using 85 Vis.-Index, Solvent Extracted, Mid-Continent SAE 30 Oil and Same Oil Treated to 2-104B and Series 2 Quality

(6000 miles—No oil change)

	Untreated Base Oil	2-104B Oil	Series 2 Oil
Varnish Deposits			
Piston skirts	5.5	6.5	10.0
Rocker-arm cover plate	7.0	7.5	9.5
Push-rod cover plate	6.5	9.0	9.0
Cylinder walls	5.0	6.5	10.0
Crankcase oil pan	7.0	7.5	9.5
Varnish total	31.0	37.0	48.0
Sludge Deposits			
Oil ring drain slots	5.0	9.0	10.0
Rocker-arm cover plate	7.5	8.0	9.0
Push-rod cover plate	6.0	7.0	8.5
Oil screen	10.0	10.0	10.0
Crankcase oil pan	8.0	8.0	8.5
Sludge total	36.5	42.0	46.0
Combined rating	67.5	79.0	94.0

dex SAE 30 base oil. The second oil was the high quality 2-104B heavy-duty oil used in the first phase of the test program, while the third oil was a 2-104B Supplemental List I type product of high detergency level containing 9% of a detergent additive.

The vehicles operated with this special fuel showed a considerably higher level of engine deposits than those operated on the fuel with minimum deposit-forming characteristics. The two detergent type oils showed a distinct advantage over the straight mineral oil in their ability to handle fuel decomposition products. Sludge and ring zone deposits with the detergent type oils were distinctly less than those with the non-additive base oil. In the light-duty truck tests, the additive type oils showed a marked advantage over the base oil in minimizing oil-screen sludge deposits. The oil screens were almost completely covered with sludge after 4000 miles operation on the base oil. With the additive type oils, the oil screens were practically clean after 4000 miles and showed only partial plugging after 8000 miles. The summary of the light truck field tests stated:

"The results indicate that significant advantages over a well-refined base oil in regard to engine deposit buildup in light truck, door-to-door delivery service can be obtained by the use of a heavy-duty oil containing a moderate concentration of detergent-inhibitor additive. It is indicated also that the use of a high concentration of a detergent additive to give an oil of considerably increased detergency level does not necessarily mean that superior performance in low-temperature gasoline engine operation will be obtained.

Sludging in Passenger Cars In City Driving is Studied

TWO types of passenger car field studies of the effect of detergent motor oils on sludge formation were included in the report by Boehm and Tongberg.[4]

The first concerned a parking lot survey to determine the extent of sludge formation in average passenger car engines operating in typical urban communities where much of the total mileage in the life of the car is accumulated in short trips. The second study involved two field test programs. In the first program the ability of detergent motor oils to control sludge formation in older or high-mileage vehicles was studied. In the second program the effect of oil composition on sludge formation was studied under rigidly-controlled conditions using a group of cars of a well known make equipped with new engines.

In the survey of sludge formation, 43 typical passenger cars, which had been operated for considerable time in a metropolitan area, were examined for engine sludge buildup. The cars selected had operated on high quality lubricating oils of known composition. The fuel used throughout the life of the cars, although not controlled, was typical of regular and premium grade gasoline sold at service stations.

The total mileage on the different units varied from about 13,000 to 134,000 miles, the median being about 35,000. The median age of the cars was 4½ years and the median oil drain 1500 miles. The cars selected were such that the age distribution on the 43 cars was roughly that of passenger cars on the road at the time the survey was made.

Inspection of the engine showed that about 35% of the 43 vehicles had reasonably heavy sludge deposits. The oil-pump screens of most of these cars with heavy sludge deposits were at least 60% plugged and in a number of cases were 100% covered with sludge. About 50% of the cars examined showed moderate buildup of sludge deposits, the remaining 15% had light deposits.

In the first phase of the second field test program, 51 passenger cars were divided into heavy-sludging and mild-sludging groups. Accessible parts were cleaned to remove all sludge deposits, but the pistons were not removed. The vehicles were then used for a qualitative 4000-mile field test on motor oils of different composition using a 2000-mile oil drain period. The cars were operated on a regular grade or premium grade of gasoline from a single refinery.

Four oils were used in the test program: 1—a high viscosity index well-refined SAE 20 base oil containing no added inhibitors or detergent additive and 2—three detergent oils formulated from the high viscosity index SAE 20 base oil with three different combination detergent and inhibitor additives. The additive concentration in each case was roughly that used in 2-104B oils.

After 4000 miles of operation about equally distributed between summer and winter driving, the cars were re-examined and rated carefully for accumulated sludge deposits. The results indicated that the detergent type oils were all superior to the straight base oil in repressing the formation of sludge deposits. The detergent oils showed to greater advantage in the heavy sludging vehicles than in those of moderate or mild sludging tendency.

This passenger car survey was regarded as indicating that, under average passenger car driving conditions in urban areas, accumulation of sludge reaches a rather high level in a significant proportion of the vehicles involved. In such average passenger cars, also, certain detergent oil compositions containing only moderate concentrations of detergent-inhibitor additives appear to be effective in minimizing the formation of sludge deposits.

The second phase of this field test program was designed to throw light on the extent and rate of buildup of sludge in passenger cars equipped with new engines and operating under average urban conditions on a gasoline of the average quality from a deposit-forming standard available to consumers. For this purpose 12 cars of a single make which had been indicated from previous experience to be more severe on sludging than other makes were equipped with new engines, and operated under normal passenger car service conditions.

A special fuel was made up designed to have deposit-forming characteristics as close as possible to the average gasoline available in the area where the cars were operated. Three lubricating oils of different composition were used. Two were well-refined base oils containing no added inhibitors or detergents manufactured from two basic types of crudes. The third oil was a high-quality 2-104B type heavy-duty oil containing 4.4% additive. Four units were operated on each type of oil, SAE 30 grade being used in the summer and SAE 10 for winter operation.

The results of these tests showed that, in the first 4000 miles of operation in the summer, only slight buildup of sludge deposits occurred. After 4000 to 12,000 miles of operation, including 2000 to 4000 miles of driving in winter weather, the heavy-duty oil showed to advantage over the straight base oils in regard to sludge deposits. However, the level of deposits, even with the straight mineral oils, was in relatively low range. There were indications that a rise in the accumulation of sludge deposits occurred during winter operations on the two straight refined oils and that no similar change in the rate of deposit formation occurred in the 4 vehicles operating on the 2-104B heavy-duty oil.

Special Oils Reduce Lacquering In Large-Bore Gas Engines

FIELD experience with the special heavy-duty oils was reported at the Symposium by Edgar and Jeffrey.[5] Gasoline engine field tests were begun over five years ago in pick-up truck service which was notable for high wear and piston deposits and generally dirty engine conditions. In tests up to 16,000 miles, clean engines were reported, as compared with observations with pre-

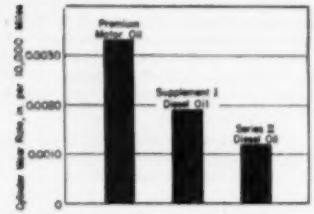

FIG. 1—Ring wear tests in Diesel engine tests with 1% sulfur fuel

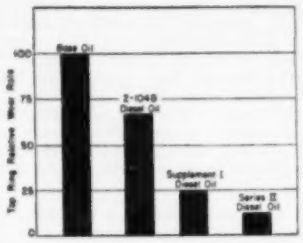

FIG. 2—Measured cylinder wear rates in passenger car field tests

mium-type motor oils. No improvement was found in wear, however.

A number of field tests in gasoline engines also are under way in city stop-and-go service, which include bakery, laundry, public utility and service station truck delivery operations with monthly mileages of about 500 to 1000. Field tests also are in progress in heavy-duty truck service, operating at high loads and temperatures where mileage per month is around 10,000.

The purpose of this work is to determine whether significant improvements in engine cleanliness and wear leading to longer engine life can be obtained, and whether there are any factors limiting the use of the new type heavy-duty oils. Typical of such factors might be undesirable increase in gasoline octane requirement, early spark plug fouling or shortened valve life, owing to rapid accumulation of combustion chamber deposits.

Results are described as limited at present, owing to the time required to accumulate significant mileages, particularly in city service. Observations here have been that clean engines stay remarkably clean and that engines which are dirty from the use of other oils tend to become somewhat cleaner with the special heavy-duty type oil. It is noted that the special heavy-duty oil has been placed in many dirty engines at several city-service fleet properties and that the plugging of oil lines by loosened deposits has been conspicuously absent.

In heavy-duty truck service where mileage per month averages around 10,000, pistons have been found exceptionally clean where the new type oils were used. The octane requirement was measured at intervals in two new trucks in service station delivery operation. One vehicle was using a premium type oil and one the special heavy-duty oil. To date no trend to increased octane requirement has been noted in the case of either vehicle.

There has not been found the sharp reduction in wear in gasoline engines with the new type oils such as was found in diesel engine applications. Equal wear rates in city service have been found between the special heavy-duty and premium oils.

Lacquering had been experienced with a variety of engines ranging from industrial models of automotive engines to fairly large-bore, medium-speed industrial engines which were in pumping service in an irrigation district in the San Joaquin Valley. Natural gas is used as fuel in all the engines. The lacquering had resulted in valve sticking and piston wrist pin seizure, which had caused valve burning and scored liners and pistons in some cases. With post-war 2-104B oils some improvement in operation was noted but none of these oils reduced lacquering substantially. Visible lacquer deposits were removed after 1400 hours operation of two of the engines on the special heavy-duty oils.

Wear Reduction Properties Shown for the New Oils

DATA on the wear reduction characteristics of the high additive oils in both gasoline and diesel engines was presented at the Symposium by C. E. Watson, California Research Corp., Richmond, Cal.(8) The company conducted a series of tests to study the effects of higher levels of lubricating oil compounding on engine wear.

The accompanying Fig. 1 shows the results of an L-1 diesel engine test using 1% sulfur fuel. By increasing the compounding through 2-104B, Supplemental List 1 and Series 2 quality levels, a marked decrease in ring wear was obtained in a diesel engine, it was stated. Supplemental List 1 oil showed about one-quarter the wear rate of base oil, while Series 2 oil showed about half the wear rate of Supplemental List 1 oil, or about one-eighth that of base oil.

Fig. 2 shows the results of similar tests in a gasoline engine operated under FL-2 test conditions. Here the Supplemental List 1 oil showed about one-third the wear rate of conventional premium motor oil. The Series 2 oil showed slightly more than one-half the wear rate of the Supplemental List 1 oil, or approximately one-fifth that of premium motor oil.

"These results have been confirmed in field tests in passenger cars operated principally in stop-start service in urban areas", stated Mr. Watson. "In these tests the cylinder wear rates were determined. The Supplemental List 1 oil showed approximately one-half the wear rate of premium motor oil, and the Series 2 oil showed about two-thirds the wear rate of the Supplemental List 1 oil, or about one-third that of premium motor oil. Both high-level oils gave very clean engines, the Series 2 oil giving the cleaner engine.

"The results of these tests indicate that, while the Supplemental List 1 oil may satisfactorily reduce engine deposits, the reduction of deposits is only a partial answer to the motorist's problem. A further advantage in reduction of engine wear can be obtained by the use of the more highly compounded Series 2 oil. This advantage can result in significantly longer engine service life."

Complete Report Available

All the papers and discussions given at the Symposium on High-Additive Content Oils, held at the First Pacific Area National Meeting of the American Society for Testing Materials, in San Francisco Oct. 12, 1949, have now been published by the society as Special Technical Publication No. 102. Bulletins are available at $1.75 for single copies, by writing ASTM headquarters, 1916 Race St., Philadelphia 3, Pa.

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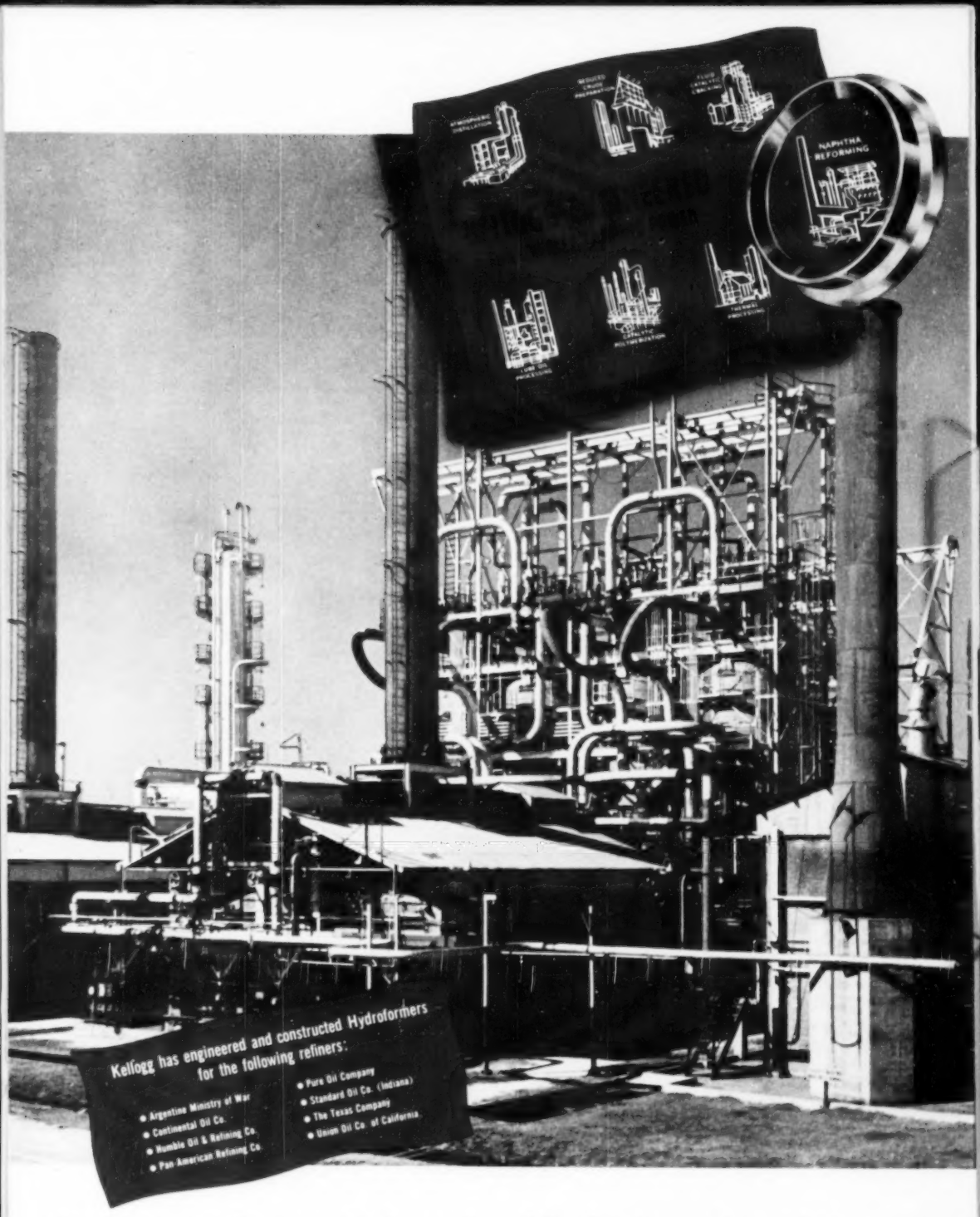
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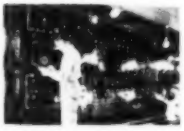

Kellogg specialists set new standards for ease of operation when the original hydroformer was built ten years ago. Still standing as one of the first units to employ graphic panels, the process also uses master and dormant cycle timers for fully automatic control. Each of the steps comprising one full cycle registers *visually* on the main panel. Audible signalling equipment, to warn of any malfunction, is present, as are push-button controls for manual operation. The job is typical of the controls and instrumentation which go into Kellogg's designs today.

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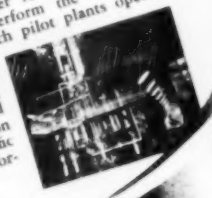

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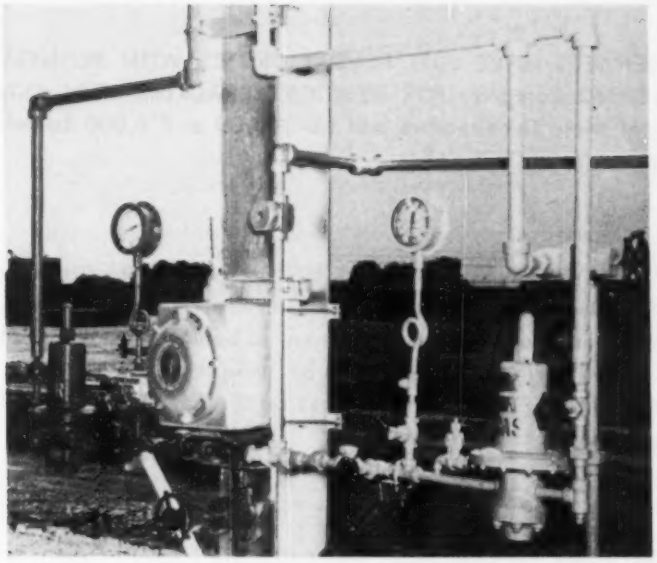

PIPING ARRANGEMENT for Ohio Oil's flare stack ignition system

LOOK-BOX, or ignition spark indicator, shown in close-up view. The spark plug had not been installed yet when photograph was taken

Ohio Oil's Flare Stack Igniters Have "Look-Box" for Safety in Operation

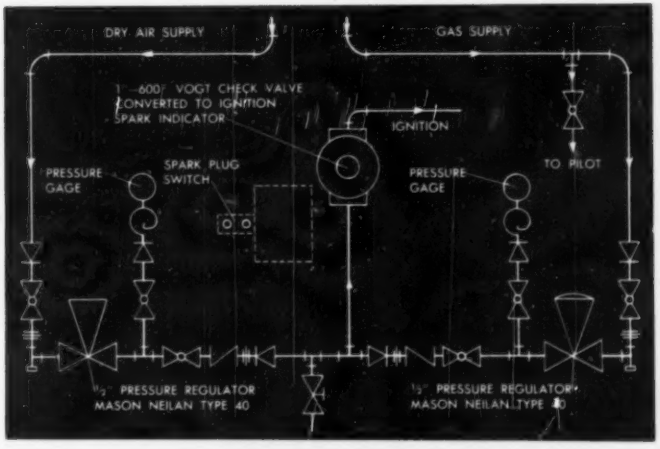

FIG. 1—Schematic diagram of piping shown in photo above

A "Look-box" built into a check valve body provides for safe ignition of the waste gas flare stacks at Ohio Oil Co.'s Robinson, Ill., refinery.

As shown in the photographs above, the look-box, or ignition spark indicator as it is termed by refinery engineers, consists of a one-inch, 600 lb., Vogt forged steel check valve blank, machined and clean on the inside without provisions for seat and bushing. There is no valve stem or plug. The bonnet has been replaced with Pyrex glass, properly gasketed to form a window for a spark plug inserted from the bottom of the body. (Spark plug was not installed when photos were taken.)

The piping arrangement is shown schematically in Fig. 1. The method of operation is as follows:

1. Adjust air and gas pressure reducing regulators (Mason-Neilan Type 40) to 5 and 3 psi. respectively.
2. Open air adjustment valve one turn.
3. Hold down spark plug switch

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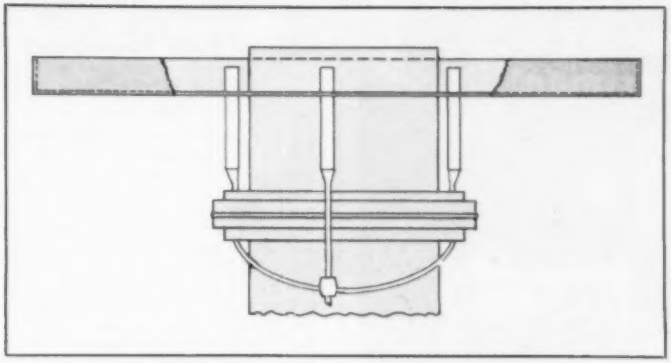

FIG. 2—Ohio Oil's flare tip assembly, showing flame stop

pushbutton and open gas adjustment valve until erratic pressure gage deflection and the sound in the ignition pipe indicate that explosions are taking place. By manipulating air and gas adjustments, optimum explosions can be obtained.

4. Release pushbutton and allow the ignition pipe to fill with the explosive gas-air mixture. With adjustments as described in Paragraph 3, rates as high as 100 ft./sec. have been obtained.

5. Close the pushbutton momentarily. A single deflection of the pressure gages indicates the flame wave is on its way to the igniters at the flare tip. Continuous sparking at this time must be avoided since the series of explosions that result will extinguish the flame wave and the flare will not ignite.

6. If after sending a flame wave to the igniters, the flare does not light, wait until the line is again full of gas and then again push the spark switch. Each successive spark sends a flame wave through the ignition line if the time interval between waves is not too short.

7. When the flare has ignited, close the shutoff valves, but leave the adjusting valves and pressure regulators set as is for future use.

8. If a pilot is desired, the gas supply can enter the flare stack near the base and be ignited as directed in the above paragraphs. Alternately, since the flame at the top of the stack lights the igniters, they may be used as pilots. In that case, it is advisable to reduce the air in the air-gas mixture to prevent overheating the igniters. An excess of gas above normal pilot use may be necessary for initial lighting but can be reduced. The stack should be full of gas before ignition is attempted.

The flare tip proper is shown in Fig. 2. Comprising the top 25 ft. of the 175-ft. stack, it is constructed of 18-8 stainless steel pipe of ¼-in. wall thickness and 16-in. diameter. Surrounding the top opening is a flame stop, a 5-ft. diameter, 18-8 stainless plate, $\frac{5}{16}$ in. thick, with approximately 4 in. high side walls. Three igniters of 1½-in. stainless pipe pass through the flame stop 6 in. from the outer wall of the stack and located at 120° intervals around its periphery.

The stack itself is mounted on top of a knockout drum. It includes a check valve and two flame arrestors in parallel. Hydrogen sulfide enters the stack through a 2-in. line separate from the normal flow of waste gases to the knockout drum, being introduced at a point about 16 ft. above the drum and above the flame arrestors and the check valve assembly.

Two flares are in use at Robinson and have given satisfactory service for about two years. Company engineers' only suggestion is that the 5-ft. diameter flame stop should have a little more bracing. It has been found to cup somewhat when gas is flared: however, the warping is not permanent. Since the refinery is located in a rural area, there has been no "smog" problem. Crude charge is from the Illinois Basin and creates no excessively sour waste gases.

Flare Stack Series

How's your "Idea File" on flare tip designs? Be sure it's complete by clipping the preceding article on a design used by Ohio Oil, as well as the four articles from previous issues of PETROLEUM PROCESSING:

Standard Oil Co. (Ohio)—July, page 736.

Pure Oil Co.—June, page 635.

Gulf Oil Corp.—May, page 511.

Humble Oil & Refining Co.—April, page 397.

Others will appear in future issues. Watch for them, or send in one of your own!

Universal Calipers Facilitate Checking Odd-Shaped Fittings, Flanges, Valves

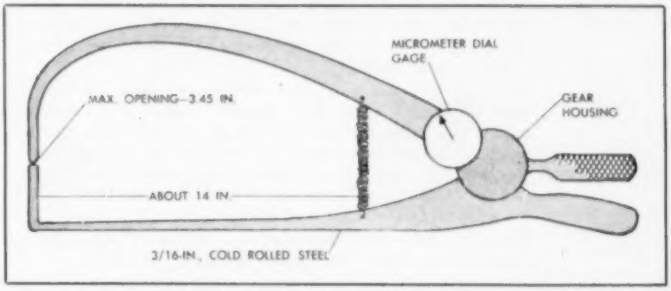

FIG. 3—Special callpers designed for checking odd-shaped equipment

UNIVERSAL fittings calipers, built in several sizes, have facilitated the inspection of flanges, valve bodies, and other irregularly-shaped, difficult-to-gage equipment at the East Chicago refinery of Cities Service Oil Co.

A typical calipers is shown in the sketch in Fig. 3. The tools have been made by Federal Products Co., Providence, R. I., following a design by Cities Service's inspection department personnel. The micrometer dial gage, calibrated to read in thousandths of an inch, is actuated by the 420-tooth gear in the adjacent housing as the jaws are opened and closed around the object to be measured.

Maximum opening is 3.45 in. The shape of the jaws, as differentiated from conventional inside or outside calipers, permits a quick check on flanges, valves, and other fittings from 2½ to 8 in. pipe size.

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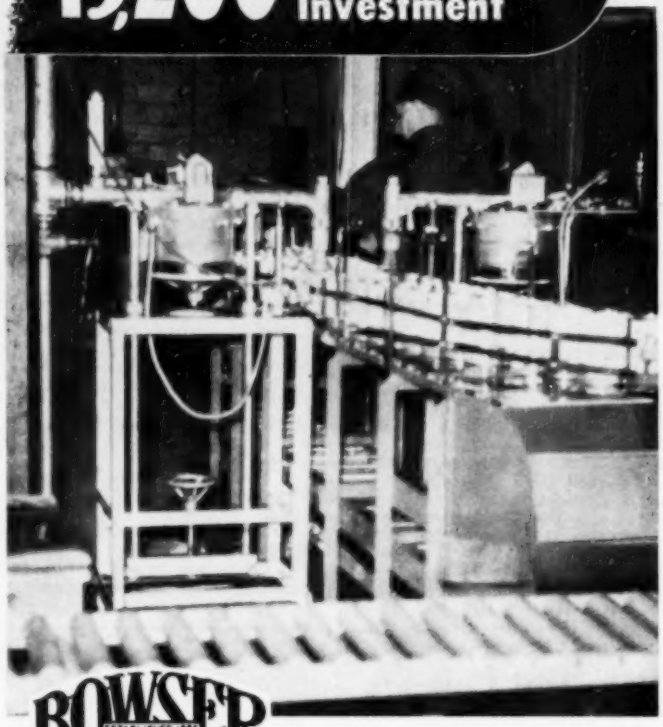

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How to Clean Salt Deposit Out of Heat Exchangers

By ROY W. MACHEN, Bay City, Texas

BECAUSE of seasonal fluctuations in the salt content of crude oil being processed by one of the smaller Southwestern refineries in their topping plant operations it was found necessary to provide for an easy way of flushing out the salt deposits in the crude-finished product heat exchangers before they became troublesome.

The needed connections were installed on the heat exchanger side of the "block" valves to the unit. They consisted of welded-in nipples, globe valves, and—as a measure to eliminate any drip that might result from a slightly leaking valve—flat plugs at each connection.

The method of operation was very simple, consisting of a determination of the minimum heat loss desired as compared to that of normal clean tube operation. When the efficiency had become impaired to such an extent that flushing was needed, the heat exchanger was by-passed for a short time, the crude in the tubes was blown out with steam admitted by means of a steam hose, and then water was injected through the bundle.

After the flushing operation, the water was blown from the bundle with steam, and the unit put back on stream. The heat efficiency was thus brought back to normal after only a short period of time with no attendant "plant shut-down" time.

Make Sample Cooler Coils On Heavy Pipe Machine

PIPE fitters at the Baltimore refinery of the Esso Standard Oil Co. have developed a novel and time saving method for turning out all small coils of pipe, particularly coils for sampler coolers. Most of these coils are fabricated of one-inch diameter pipe rolled into a coil, usually 12 in. in diameter. Occasionally, however, coils are made of pipe anywhere from ¼ up to 2 in. in diameter.

The procedure consists of rolling the desired pipe around a length of 10-in. pipe which has been fitted in the back end of the heavy duty pipe machine. A U-bolt is put through the wall of the 10-in. pipe and one end of the coil pipe is clamped with this bolt. Then the pipe machine is rotated slowly under power and the small diameter pipe is fed to the machine. In this way any length coil can be made to meet most requirements of the plant. A uniform coil is easily manufactured by one man except of course in the case of the larger diameter pipe.

[*To obtain more data on advertised products see page* 882]

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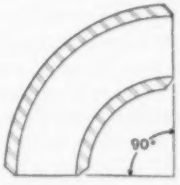

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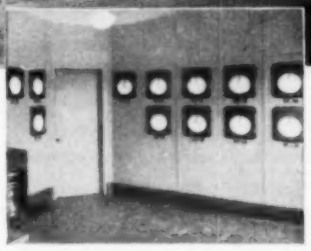
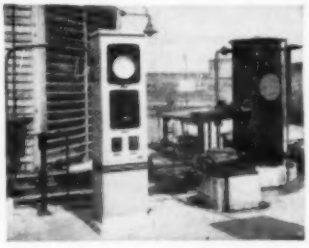


One corner of the control room, showing a few of the M-40 Controllers which automatically operate the process.



pH controller for cooling tower. It holds pH of process cooling water within desired limits.

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Multi-Column Molecular Still Has Use In Difficult Hydrocarbon Separations

A MULTICOLUMN, countercurrent molecular still has been designed by Dr. S. L. Madorsky of the National Bureau of Standards which appears to have significant advantages for the commercial separation of liquids which differ in their molecular weights or vapor pressures but have similar properties otherwise. Among possible applications cited for the new device are the purification and concentration of lubricating oils, high-boiling petroleum fractions, vegetable oils and animal fats.

The columns of the still[1] are arranged in such a way that the condensates move by gravity from column to column in one direction while all the residues move similarly in the opposite direction. Countercurrent refluxing with automatic recombination of fractions is thus obtained, and the desired separation of fractions is accomplished in a single operation.

The term molecular distillation has been applied to that type of distillation where there is no return of escaping molecules to the evaporating surface. This is accomplished by operating with high-boiling (low-vapor-pressure) liquids under such high vacuum that the mean free path of the escaping molecules is of the order of the distance between the surface of the evaporating liquid and the cooled condensing surface of the still.

In molecular distillation, the relative rates of escape of various kinds of molecules from a composite liquid surface are determined by two factors: (1) the vapor pressure (or the boiling point) of each component, and (2) the average molecular velocity of each component. Since molecular velocities, at a given temperature, are inversely proportional to the square roots of the atomic weights, molecular distillation offers a very practical means for the separation of any mixture of high-boiling substances differing in molecular or atomic weight. It is especially useful in the separation of hydrocarbons which do not differ appreciably in boiling point or are unable to withstand the high temperatures of ordinary distillation.

To avoid the necessity of making repeated cuts, with consequent reduction in output, countercurrent molecular stills have been designed in which a number of single-stage stills are so connected that recombination of fractions takes place automatically by gravity feed.[2] Then the material to be concentrated can be fed into the system at one end, or at the midpoint if both light and heavy fractions are of interest; and the concentrate can be withdrawn continuously. Countercurrent stills of this type consist of a long column placed at a small angle to the horizontal and divided into cells with an evaporating surface of a few square centimeters of each cell. Such stills have one disadvantage. As the openings between the cells must be relatively large, some mixing of vapor takes place; thus each cell represents merely a subdivision of the column and not an actual single-stage column.

In the multicolumn still developed at the Bureau, each column corresponds to a single cell in the earlier types of countercurrent stills. Mixing of the vapor between stages is thus eliminated, with a corresponding increase in the efficiency of the distillation process. To permit operation on a commercial scale, a large evaporating surface is provided, and the evaporating liquid is spread in a thin film to reduce the hold-up. In addition, the thin film is kept in continuous motion over a rough granular surface; this causes thorough mixing and thus prevents depletion of the lighter constituents.

The Bureau's still consists of 10 columns of Pyrex glass, although any number of columns can be used, and they may be made of other materials such as metal. The columns are arranged in a line at successively higher levels and are connected in

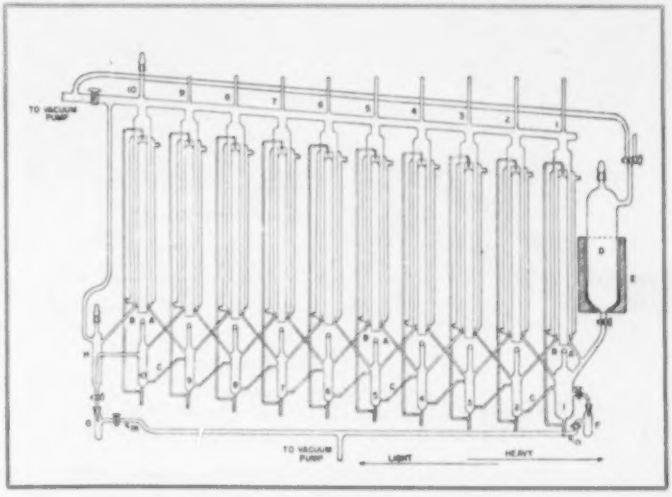

FIG. 1—The multi-column, molecular still developed by the Bureau of Standards. Columns are arranged at successively lower levels from left to right. Condensates and residues move by gravity from column to column in opposite directions. The magnetic pumps in the reservoirs below the columns keep the liquid moving from these reservoirs to the column tops. Residue from each column, except the lowest, flows through outlet A into the reservoir of the adjacent lower column; and condensate from each, except the highest column, flows through outlet B into the reservoir of the adjacent higher column. Residue from the lowest column flows back into its own reservoir while condensate from the highest column flows into a light fraction receiver H, and from there into the reservoir of the tenth column. Fractions of condensates in excess of residues flow by gravity from reservoir to reservoir in the light-to-heavy direction through overflow tubes C. Reservoir D, surrounded by a Nichrome heater E, serves to de-gas the liquid before it enters the still. Samples of the concentrates can be removed at cups F and G without interrupting the distillation

such a way that the residues or heavy fractions flow from column to column in the downward direction while the condensates or light fractions are pumped from column to column in the upward direction. The overall operation is such that the light fraction increases in concentration near the lower end. (see Fig. 1).

Each column consists of a central tube, which serves as an evaporator, surrounded by a water-cooled condenser. Below every column is a combination of magnetic pump and reservoir. The liquid is pumped from the reservoir through a feed line into a distributing cup at the top of the column, and from there it spreads over the evaporator in a thin layer. A short ring partition at the lower end of the annular space between the evaporator and condenser forms two concentric annular troughs with a separate outlet from each trough. These troughs and outlets separate the residue flowing down the evaporator from the condensate flowing down the condenser. The residue from each column, except the lowest, flows into the reservoir of the adjacent lower column; and condensate from each column, except the highest, flows into the reservoir of the adjacent higher column. The residue from the lowest column flows back into its own reservoir, while condensate from the highest column flows into a light fraction receiver and from there into the reservoir of the highest column. A large reservoir surrounded by a nichrome heater serves to degas the liquid before it is introduced into the still. Then, in passing through each feed line the material is preheated to a temperature near that of the evaporator.

The evaporator is 45 cm. long and has an outside diameter of 2.5 cm. This provides an evaporating surface of over 300 square cm. To facilitate uniform distribution and mixing of the liquid layer, the evaporating surface is covered with a thin layer of sintered powdered glass. As the condenser tube has an inside diameter of 4.1 cm., the distance between the evaporating and condensing surfaces across the annular space is 0.8 cm.

The magnetic pump at the base of each column consists essentially of a piston fitting closely within the glass reservoir tube and containing an iron core at its upper end. A solenoidal coil surrounds the glass tube in the region of the iron core. When a current flows in the solenoid, the piston moves up and draws liquid from the reservoir through a check valve into a space below the piston. Then when the current is off, the piston drops by gravity, closing the check valve and forcing the liquid through another check valve into the delivery tube.

In a multicolumn still of this type, unless precautions are taken, a gradual accumulation of liquid in some reservoirs and a depletion in others may be expected. This difficulty is avoided in the Bureau's apparatus in two ways: First, the magnetic pumps are constructed as uniformly as possible, and the amplitudes of the pump pistons are equalized. Second, the evaporating rate is adjusted to a little over one-half the rate at which liquid is pumped into the distributing crown of each column, and the excess condensate is allowed to flow by gravity through overflow tubes from column to column in the downward direction. This arrangement also serves to reflux the light fractions from the light reservoir down to the lowest reservoir.

References

(1) For further details, see "A Multicolumn Countercurrent Still," by Samuel L. Madorsky, *J. Research NBS*, 44, 135 (1950), RP 2064.

(2) Countercurrent Reflux Still for Isotope Separation, *NBS Technical News Bulletin*, 31, 33 (1947).

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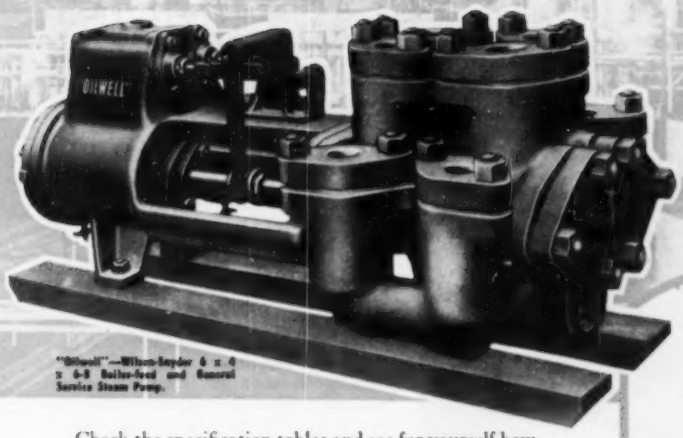

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3	.69	14	21	28	35	41	48	55	62
3½	.95	19	29	38	48	57	67	76	86
4	1.26	25	38	50	63	76	88	101	113
Slip		5%	5%	10%	10%	10%	10%	10%	10%

STALLING PRESSURES — Pounds per square inch

Piston Size Inches	Steam Pressure (Pounds per sq. in.)						
	100	150	200	250	300	350
3	480	680	880	—	—	—
3½	395	448	598	735	—	—
4	225	340	450	565	675	790

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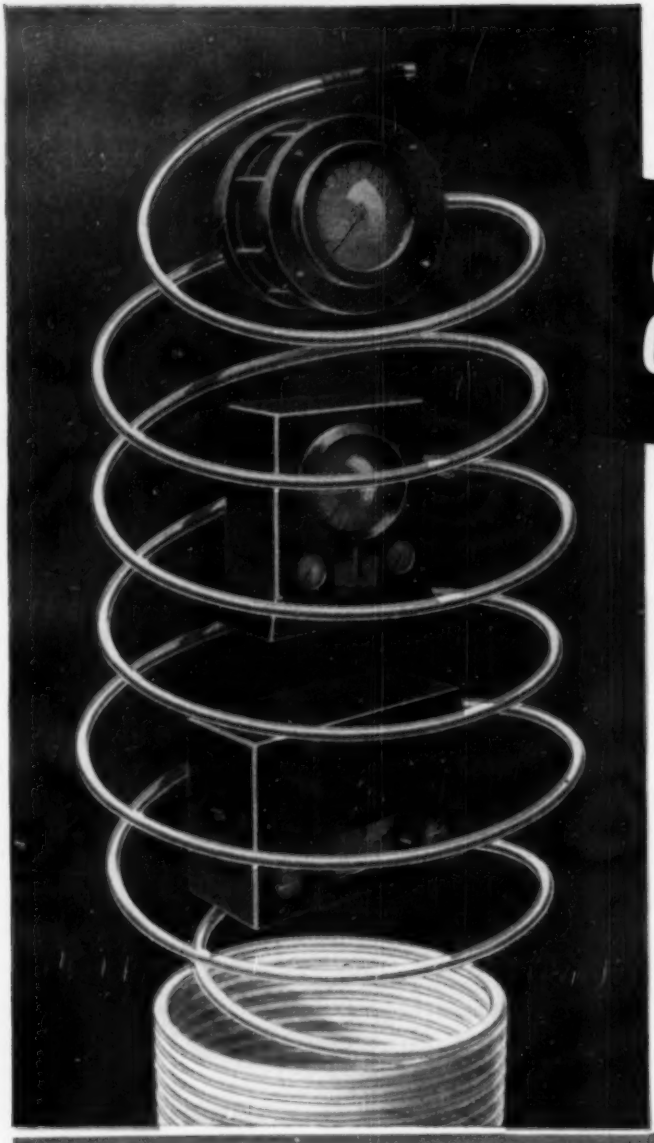

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Patent Trends in Petroleum Refining

By Peter J. Gaylor, Editor "The Technical Survey"

Condenser Corrosion in Fixed Bed Cracking Units

IT has been found by Standard Oil Co. (Ohio) that condensers in fixed bed type catalytic cracking units become quickly corroded during operation of such units. These condensers are made of bundles of tubes of copper alloy (usually antimony admiralty metal) and have spacers and baffles of steel around which flow the reaction products. Steel usually forms a protective oxide or sulfide film at pH levels above 7.0, but is subject to extensive corrosion at pH levels below 6.5. On the other hand, copper alloys resist corrosion at pH levels below 7.0, but do not form oxide or sulfide films for protection by basic solutions. Surprisingly, both steel and copper alloy parts as well as the condenser shell, become considerably corroded on the oil side during the operation of the cracking unit. In fact, the corrosion is so extensive as to eventually plug the condenser completely or cause excessive leakage.

In typical fixed bed catalytic cracking, an oil charge, usually together with some steam, is passed through the catalyst cracking bed. The catalyst is regenerated periodically by passing air through it, say every 30 min. The cracked products and steam pass from the cracking chamber to a fractionating tower equipped with conventional condensers in which heavier hydrocarbons and steam are condensed and led to an oil and water separator to remove the condensed water.

Periodic analyses of this condensate water has shown that, during the cracking part of the operation cycle (which is usually 10 min.), the pH of the water varies through a range of about 5.0 to 8.7. This variation is believed to be due to the fact that, at the beginning of the cycle when the charge contacts the catalyst that has just been regenerated with air, some organic acids are formed by reaction of hydrocarbons with adsorbed oxygen, and these acids apparently are formed in sufficient quantity to offset, during a portion of the cracking part of the cycle, any basicity due to the formation of ammonia from nitrogen compounds in the charge, with the result that the pH goes below 6.5. As the cracking proceeds and the adsorbed oxygen is consumed, the acid formation decreases, so that the pH at the latter portion of the cycle reaches a peak level of over 8.0. This has led to the conclusion that the steel parts of the condenser are corroded during the early part of the cycle, while the copper alloy tubes are corroded later. The situation also is believed to be aggravated by the fact that the periodic lowering of the pH into the range below 6.5 either prevents the formation of a protective oxide film on the steel parts or destroys such films which may be formed during the latter portions of the cycle when the pH is over 7.0.

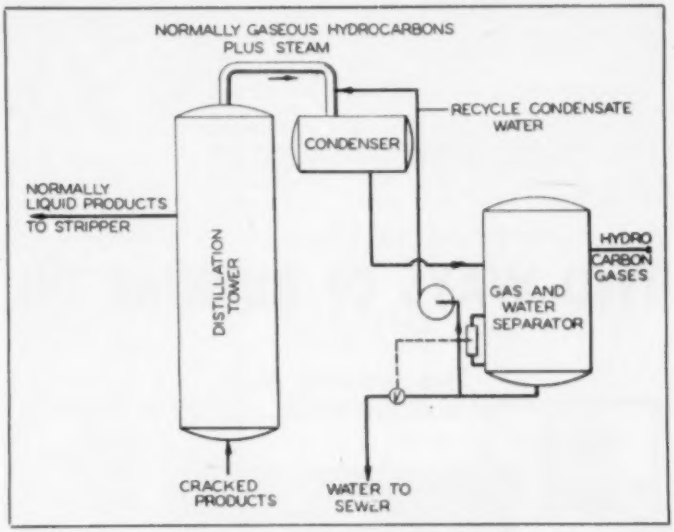

FIG. 1—Hook-up for minimizing condenser tube corrosion in fixed bed cracking (U. S. 2,499,435)

In its U.S. patent 2,499,435, the firm remedies this situation by collecting the water from the conventional oil and water separator and recycling it through the oil side of the condenser, which has the effect of minimizing the pH fluctuations to a far greater extent than would be expected on the basis of calculations. This recycle condensate water stream is depicted in Fig. 1 which shows the units mentioned in the preceding discussion.

Catalytic Reforming

A RECENT patent (U.S. 2,508,-014), issued to Shell Development Co. describes a hydroforming operation in which naphtha and hydrogen are subjected to 825°-1025° F. at 500 psig. or above, in presence of an impregnated molybdenum oxide-alumina catalyst promoted with 0.6-8% silica and 2.5-12% zinc oxide, the amount of molybdenum being in excess of the zinc in the catalyst. The silica should be incorporated prior to the zinc and molybdenum oxide.

Separation of Hydrocarbons By Forming Urea Complexes

DURING the last year, several papers have been presented by workers of Shell Development Co. on the separation or concentration of certain types of hydrocarbons, when in admixtures with other types, by means of formation of solid complexes with urea.

A recent patent issued to this firm (U. S. 2,499,820) discloses that thiourea also forms hydrocarbon complexes which may be used for separation or concentration purposes. These complexes may be either crystalline or non-crystalline (fluid or oily), and they are generally insoluble in water, or soluble only to a slight extent. The crystalline complexes are somewhat soluble or dispersible in hydrocarbons. At or below room temperatures, the two types of hydrocarbons which form complexes with thiourea most readily are isoparaffins and naphthenes.

Although the exact nature of these

complexes is unknown, they appear to be molecular in character, both the hydrocarbon and the thiourea being readily recoverable in substantially pure form by heating or steam distillation. Also, it has been found that a critical temperature exists (all other conditions being equal) above which a given complex will not crystallize and, in this respect, these complexes resemble hydrocarbon hydrates.

Complexes may be formed having varying amounts of thiourea combined in molecular complex with the hydrocarbons. When the temperature or other conditions are such as to favor a combination of about three mols of thiourea with about every four carbon atoms of the hydrocarbon, it is a preferred practice to contact the hydrocarbon with an amount of thiourea in excess of this ratio.

Apparently, the best method for forming the complex involves treating the hydrocarbon mixture with an aqueous alcohol solution of thiourea, when the complex crystallizes out and may be filtered, washed with n-pentane, and steam distilled to recover the hydrocarbons, the urea remaining in the aqueous solution.

Among the isoparaffins which form such crystalline complexes are isopentane, isooctane, 2, 3 dimethylbutane, and 2, 2, 3 trimethylbutane, while the naphthenes include methyl cyclopentane, cyclohexane, methylcyclohexane, 1, 2 dimethyl cyclohexane, 1, 3, and 1, 4 dimethyl cyclohexane and decalin. When a mixture of 50% 1, 2 dimethyl cyclohexane and 1, 4 dimethyl cyclohexane is so treated, the thiourea complex contains predominantly 1, 4 dimethyl cyclohexane. A similar mixture of 1, 4 dimethyl cyclohexane and ethyl cyclohexane gives a complex containing predominantly ethyl cyclohexane.

Among the important uses proposed for the process is the separation of naphthenes from aromatics, triptane from alkylates, etc.

Blended Lubricating Oils Of Stable Pour Points

IT has been known for some time that certain pour inhibitors, although excellent in reducing the pour point of a waxy oil in the ASTM pour point test, have not exhibited the same results under conditions of repetitive freezing and thawing which generally take place in winter storage. Under these latter conditions, the blended oils were found to have much higher pour points than when tested by the ASTM pour point test method prior to shipment. This latter property has been designated as pour stability (or instability), and a pour stability test has been developed which is often used in conjunction with the usual ASTM pour point determination.

According to a Standard Oil Development patent (U.S. 2,491,683), the pour stability of lubricating oils containing "Paraflow" pour inhibitor (such as one made under the Davis patent U.S. 1,815,022), may be improved considerably by the addition, with the pour inhibitor, of a polyfumarate ester prepared by polymerizing a fumaric acid ester of a mixture of alcohols marketed under the name "Lorol B", the composition of which is given. The polymer is preferably one of 1000-5000 molecular weight, which range does not make it a very effective viscosity index improver, since molecular weights up to 20,000 are more effective for this latter characteristic. Also, the polyfumarate employed possesses little pour inhibiting effect.

The curves shown in Figs. 2, 3 and 4 illustrate the type of results which have been obtained with the two additives in a waxy lubricating oil blend. In Fig. 2, the concentrations of polyfumarate (A) are plotted against those of Paraflow inhibitor (B), and the satisfactory blends with respect to ASTM pour point are indicated by the heavy dotted line.

Fig. 3 is a similar plot of such blends with respect to pour stability, those concentrations giving satisfactory pour stabilities being included above the solid line shown. By superimposing Fig. 2 on Fig. 3, Fig. 4 is obtained, and the blends showing sat-

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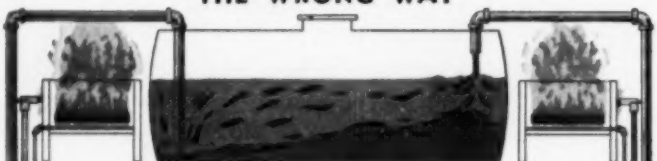
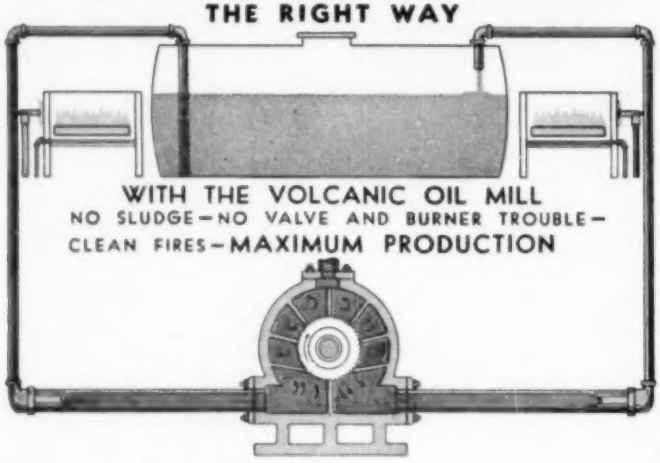


SLUDGE IN STORAGE—VALVE AND BURNER TROUBLES—
UNBURNED OIL—LOST PRODUCTION

THE RIGHT WAY



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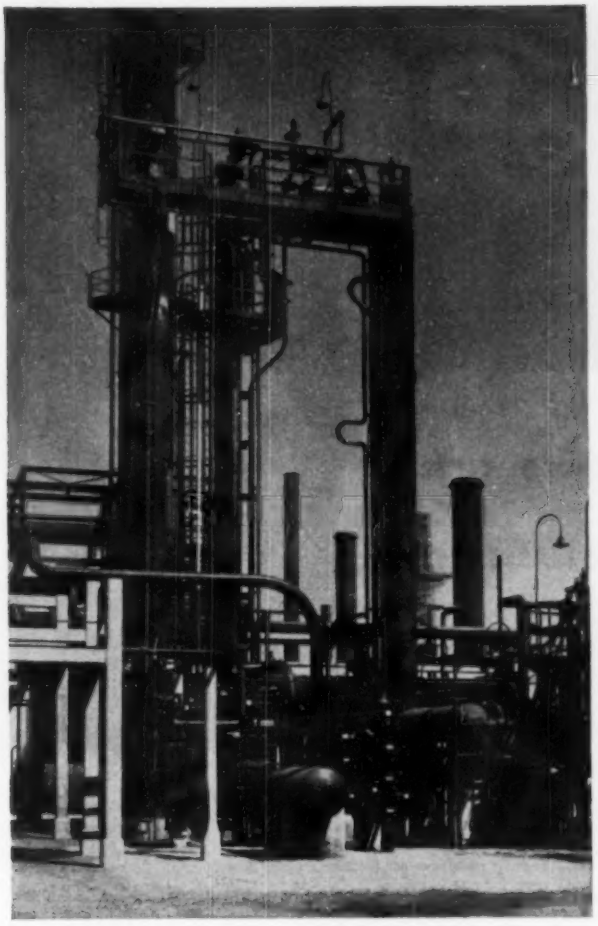
[To obtain more data on advertised products see page 882]



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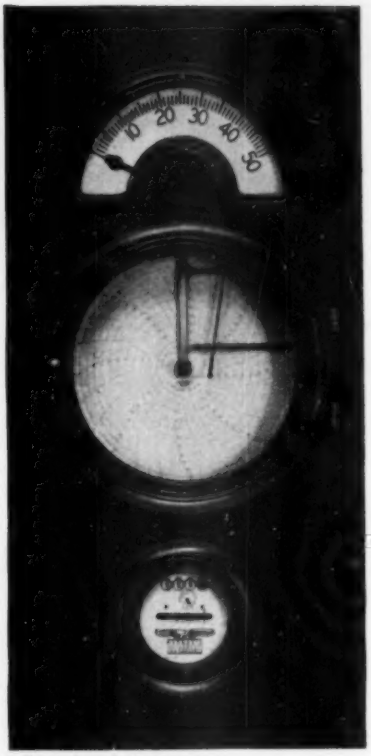

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isfactory results with respect to both pour point and pour stability are embraced by the shaded area between the two curves.

In other words, the two primary additives (polyfumarate and alkylaromatic pour inhibitor), must be added to the lubricating oil base stock within a particular range of propor-

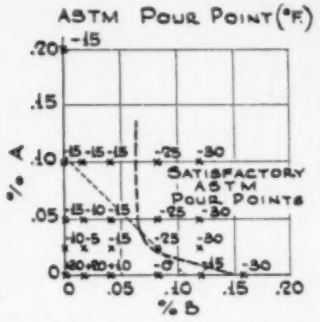

FIG. 2—Pour points of polyfumarate (A) and Paraflow (B) blended lubricating oils (U. S. 2,491,683)

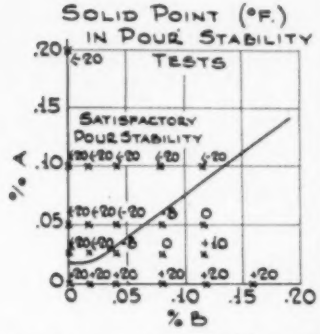

FIG. 3—Pour stabilities of polyfumarate (A) and Paraflow (B) blended lubricating oils (U. S. 2,491,683)

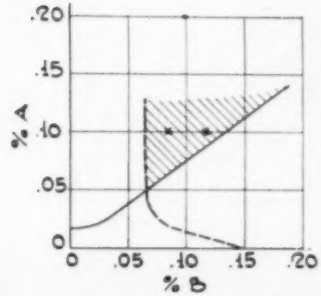

FIG. 4—Comparison of blends with respect to pour point and pour stability (U. S. 2,491,683)

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tions to obtain the desired cooperating effect. The amount of pour inhibitor used should be in the range of 0.5 to 2 parts by weight for each part of polyfumarate employed, and the total amount of mixture used should preferably be about 0.1% to 2%.

Patents Issued in June

The following classified listing gives the patent number, patentee or assignee, and a brief description of all patents believed to be of direct interest to the petroleum processing industries, as contained in the Official Gazettes of the U. S. Patent Office for June 6, 13, 20 and 27, Vol. 635, Nos. 1-4.

Fuels

Re. 23,239 (Universal Oil Products Co.)—Gasoline inhibitor (olefin stabilizer).
2,511,433 (Fiala)—Nitrating kerosine.
2,512,649 (USA)—Isononanes.

Conversions

2,510,189 (Union Oil Co. of Calif.)—Alumina supported Co-Mo conversion catalyst.
2,510,444 (Sinclair Refining Co.)—Apparatus for pyrolytic conversion of hydrocarbons.
2,510,673 (Pure Oil Co.)—Reforming gasoline.
Re. 23,241 (Lummus Co.)—Recycling catalyst fines in a catalyst conversion system.
2,510,994 (Houdry Process Corp.)—Hydrocarbon conversion with use of a precipitated and calcined Be catalyst.
2,511,402 (Sinclair Refining Co.)—Catalytic conversion of hydrocarbons.
2,512,562 (Sun Oil Co.)—Catalytic reaction apparatus.
2,513,103 (M. W. Kellogg Co.)—Isomerization with HF-BF_3.
2,513,253 (Standard Oil Development Co.)—Handling suspensions of solids in gases.

Refining

2,511,206 (Tennessee Eastman Corp.)—Separating acetylene and propylene from other hydrocarbons.
2,511,251 (Socony-Vacuum Oil Co.)—Desulfurization by condensing S compounds with keto group.
2,511,478 (Socony-Vacuum Oil Co.) — Desasphalting and dewaxing hydrocarbon liquids.
2,512,040 (Atlantic Refining Co.)—Recovery of hydrocarbons from gaseous mixtures by freezing.
2,512,570 (Shell Development Co.)—Desulfurizing hydrocarbons by hydrogenation.

Chemicals

2,510,806 (Standard Oil Development Co.)—Purifying alcohols.
2,510,808 (Standard Oil Development Co.)—Plasticizing isobutylene-diolefin rubber.
2,510,882 (Standard Oil Development Co.)—Stable dispersion of phenyl beta naphthylamine.
2,511,454 (Socony-Vacuum Oil Co.)—Nitration of paraffins.
2,511,621 (California Research Corp.)—Esters of cyclohexadiene polycarboxylic acids.
2,511,653 (Sinclair Refining Co.)—Alpha-methoxy-propionitrile.
2,511,728 (Standard Oil Development Co.)—Analyzing substance by mass spectrometry.
2,511,758 & 810 (Phillips Petroleum Co.)—Ethyl alcohol and alkylate.
2,511,818 (Hooker Electrochemical Co.)—Photo-chlorination of paraffinic hydrocarbons.
2,511,847 (Standard Oil Development Co.)—Extractive distillation of sec. butanol from methyl ethyl ketone.
2,511,890-1 (Shell Development Co.)—Heterocyclic compounds.
2,511,915 (Phillips Petroleum Co.)—Chloronitro compounds.
2,511,957 (Phillips Petroleum Co.)—Tetralin oxidation to hydroperoxide.
2,512,327 (Standard Oil Development Co.)—Sulfuric acid recovery in ethyl alcohol manufacture.
2,512,410 (Shell Development Co.) — Alkyd resins.
2,512,504 (Standard Oil Development Co.)—Stabilizing xylidene.
2,512,587 (Commercial Solvents Corp.)—Temperature control in hydrocarbon nitration.
2,512,596 (Phillips Petroleum Co.)—Alkenyl thiophenes.
2,512,660 (Phillips Petroleum Co.)—Pyridine derivative.
2,513,131 (Standard Oil Development Co.)—Inhibiting corrosion of sulfuric acid with BF_3.
2,513,132 (Shell Development Co.)—Amino alcohols.
2,513,133 (Shell Development Co.)—Saturated dihydric alcohols.
2,513,179 (Sun Oil Co.)—Alcohol from 1-vinylcyclohexene 3.
2,513,183 (Sun Oil Co.)—Copolymer products.
2,513,243 (Standard Oil Development Co.)—Polymers from the cyclic dimers of diolefins.
2,513,2?2 (Standard Oil Development Co.)—Diolefin distillation.

Lubricants

2,510,540 (Shell Development Co.)—Homopolymeric ethers of 1,2-epoxy linear hydrocarbons as synthetic lubricants.
2,511,250 (Gulf Research & Development Co.)—Extreme pressure lubricant stabilized with triethanolamine petroleum sulfonate.
2,511,630 (Shell Development Co.)—Lubricant and P-S compound stabilizer.
2,511,731 (Standard Oil Development Co.)—Extreme pressure additive.
2,511,744-50 (Gulf Oil Corp.)—Lubricating oil antioxidants.
Re. 23,243 (Shell Development Co.)—Reversible lubricating grease.
2,512,359 (Atlantic Refining Co.)—Lubricant containing beryllium carboxylate.
2,512,444-5 (Gulf Oil Co.)—Antioxidants for mineral lubricating oils.
2,512,784 (Shell Development Co.)—Stabilized lubricant.
2,513,060 (Gulf Oil Corp.)—Lubricant containing organic oxidized and sulfurized esters.
2,513,061-3 (Gulf Oil Corp.)—Antioxidant for mineral lubricating oils.

Hydrocarbon Synthesis

2,510,096 (Hydrocarbon Research, Inc.) — Synthesis of hydrocarbons and oxygenated hydrocarbons.
2,510,823 (Standard Oil Development Co.)—Sintering synthesis catalyst.
2,512,608 (Standard Oil Development Co.)—Iron synthesis catalyst coated with Al.
2,513,022 (Phillips Petroleum Co.)—Hydrogen from hydrocarbons and steam.

Specialties

2,510,771 (Pure Oil Co.)—Protecting metal surfaces against action of hydrogen sulfide by hardwood tar distillate.
2,510,839 (Standard Oil Development Co.)—Herbicidal composition.
2,511,088 (The Texas Co.)—Pelleting carbon black.
2,511,474 (The Texas Co.)—Spraying heavy particles immersed in low viscosity liquid.
2,511,901 (Phillips Petroleum Co.)—Agglomeration of carbon black.
2,512,255 (Gulf Research & Development Co.)—Naphthenic acid ester hydraulic fluid.

Miscellaneous

2,512,773 (Texaco Development Corp.)—Radiation detecting device.

How to Obtain Patents

Readers may obtain copies of any U. S. patent from the Patent Office at 25 cents each. Order by patent number direct from the Commissioner of Patents, Washington 25, D. C.

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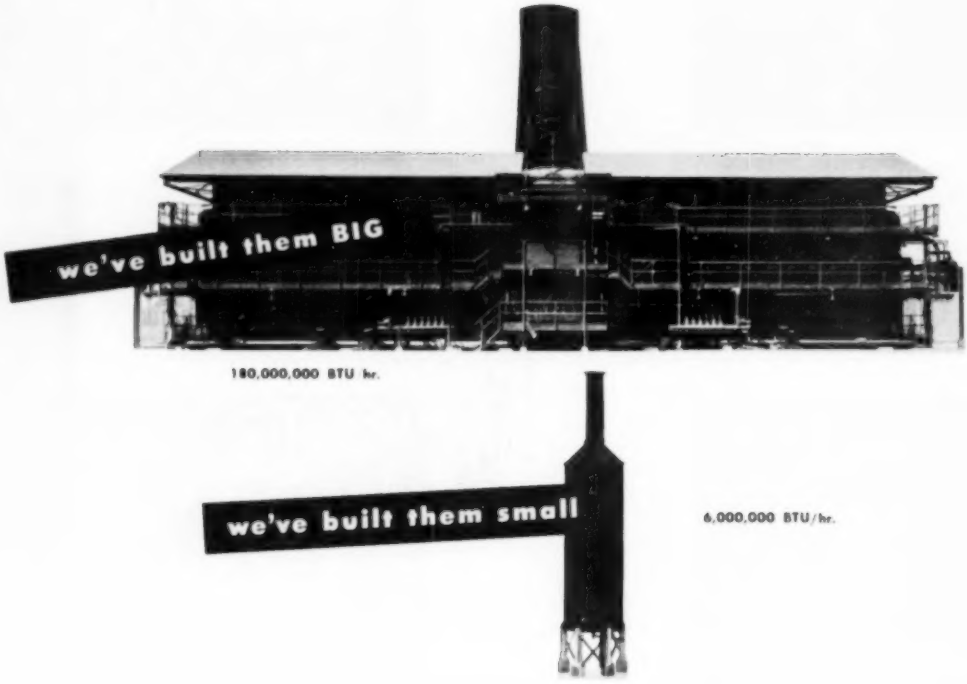

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Remote Indicator Is Feature of Gage for Long Vertical Tubes

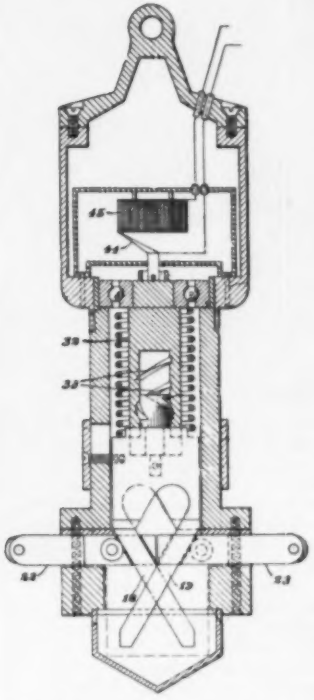

FIG. 1—Tube gage designed for remote indication of variations in diameter (U. S. 2,512,986)

A TUBE GAGE has been developed for use particularly in measuring and checking the bores of long, vertical tubes or pipes such as those in a De Florez still. Its featured advantage over previous designs is said to be in the use of remote indication by electrical means. The gage is illustrated in cross section in Fig. 1.

In use, the gage is allowed to pass down through a furnace tube by being suspended at the eye at the top of the casing. As it moves through the tube, the gage pins 22 and 23 touch the inner walls of the furnace tube, making contact by means of rollers. Variations of internal diameter cause pins 22 and 23 to move in or out of the casing. This movement in turn is transmitted to crossed plungers 18 and 19 on the lower end of an actuating rod 17 inside the casing. Rod 17 is held down and gage pins 22 and 23 are held out by a compressed coil spring.

As rod 17 is forced upwardly within the casing by the action of the gage pins, it causes cylinder 32 to revolve through the action of the spirally threaded grooves 33. This rotation in turn is transmitted to a contact arm 44 which travels along the resistance coil 45. Arm 44 and coil 45 are part of a low voltage electrical circuit which includes a conventional electrical current flow indicator outside the tube (not shown), and which can be calibrated in terms of tube diameter.

U. S. 2,512,986, issued June 27, 1950, to Charles H. Woodcock and William H. Stinger, assignors to Atlantic Refining Co., Philadelphia.

Pipe Cutter Forms No Burrs On Inside Wall of Pipe Ends

PIPE CUTTERS of conventional design tend to deform the severed pipe ends to the extent of building up internal burring, undesirable where such pipe is subsequently joined by welding because of the resultant effects on the inside diameter and flow capacity. A recently patented cutter designed to overcome this problem is shown in enlarged detail in Fig. 2.

The cutting wheel, or roller, 14 is generally of a frusto-conical shape with a series of annular ridges 42 and 43 tapering down to a relatively thin cutter tip 46, sharper than the usual cutter wheel. As a result of this design, the cutter operates to a particular advantage during the first piercing of the outer pipe wall as well as during the final stage of cutting. Because it makes a true incision at the finish of the cutting, operation with only a very light pressure is required and there is little chance for ridges or burrs to be formed on the inside. In addition, the general shape of the cutter causes the pipe wall metal to build up on the outside, as indicated at points B.

The supporting roller has a cross section as illustrated, with even diameter portions 30 and 31 on either side of the cutting section and a central groove 32 to allow for the outward build-up of metal at points B.

U. S. 2,511,358, issued June 13, 1950, to Albert C. Mayer, St. Louis, Mo., and Joseph J. Blackmore, Edwardsville, Ill.

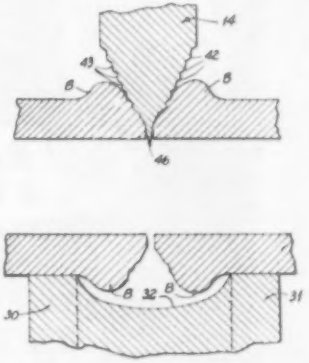

FIG. 2—Pipe cutter has specially designed cutting wheel to eliminate inside deforming on pipe (U. S. 2,511,358)

Cascade Type Trays Increase Fractionating Efficiency

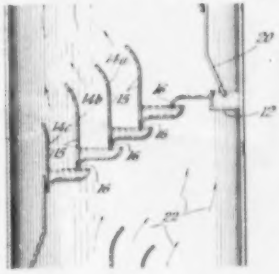

FIG. 3—Modified design for cascade type fractionating trays (U. S. 2,510,590)

FRACTIONATING TRAYS of the so-called "cascade" type, first introduced about two years ago, have been modified in a recent patent for a design which will improve overall tower efficiency as much as 25%, it is stated. Efficiency is raised by materially reducing liquid entrainment in the released vapors at each stage.

The design, shown in Fig. 3, is said to provide a particular angularity for the respective baffle plates so that a greater travel of vapors is effected. Also, a reversal of direction of the vapors causes more complete throwing out of the entrained liquid.

In action, liquid entering trap 12 from downcomer 20 from an upper stage is fed into one of the parallel vapor streams 22 entering from a lower stage. The resulting mixture is hurled violently against the solid lower portion of baffle 14, 14a, 14b, etc., with the velocity creating con-

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siderable centrifugal force as the mixture flows along and up the baffle, forcing all the liquid and a portion of the vapor through perforations 15. As the load increases, the froth is thrown higher along the face of the baffles.

The liquid separates from the vapor on the opposite face of the baffles in a vigorous bubbling action and flows down to feed into the next lower trough 16, where the operation repeats. Due to the stair-step arrangement of troughs, there is no chance for liquid build-up and large quantities of liquid can be handled. Due to the violence of mixing, the liquid is broken up into very fine droplets and high fractionating efficiency is obtained even with cold and relatively viscous oils such as are found in absorbers.

U. S. 2,510,590, issued June 6, 1950, to Wheaton W. Kraft, assignor to Lummus Co., New York City.

Patents Issued in June

The following classified listing covers patents issued during the month of June believed to be of interest or value to petroleum processing or handling operations:

Catalytic Reactors

2,510,444 & 2,511,652 (Sinclair Refining Co.)—Fluid catalytic conversion unit.
2,512,562 (Sun Oil Co.)—Fixed bed type catalytic reaction equipment.
2,513,253 (Standard Oil Development Co.)—Equipment for handling fluidized catalyst.

Processing, general

2,510,556 (The Lummus Co.)—Bubble cap and riser tube assembly.
2,510,586 (The Lummus Co.)—Bubble cap hold-down device.
2,510,589 (The Lummus Co.)—Bubble cap.
2,510,590 (The Lummus Co.)—Fractionator trays of the so-called "cascade" type.
2,511,351 (Clarence D. Laidley)—Improved drain for mist extractors in liquid and gas separators.
2,511,387 (Aerotec Corp.)—Equipment for centrifugal separation of suspended particles from gaseous media.
2,511,813 (Socony-Vacuum Oil Co., Inc.)—Device for connecting a transfer line to a high temperature reaction chamber.
2,511,967 (Julian A. Campbell)—Separator for removing liquid entrainment from gas.
2,513,174 (Selas Corp. of America)—Gas filter.

Tools

2,510,483 (Lawrence C. Schnepel and Everett C. Spear)—Speed and power geared hand wrench.
2,510,660 (Barcalo Mfg. Co.)—Adjustable jaw pliers.
2,511,270 (Benedict D. Kahan)—Cylindrical slide rule.
2,511,358 (Albert C. Mayer and Joseph J. Blackmore)—Pipe cutter.
2,511,470 (William B. Johnson)—Thread cutter.
2,512,705-6-7 (Air Reduction Co. Inc.)—Gas-shielded arc welding torches.
2,512,986 (Atlantic Refining Co.)—Tube gage for checking inside walls.

Pumps and Motors

2,510,609 (William W. Tingle)—Variable capacity hydraulic rotary pump or motor.
2,511,337 (The Duriron Co.)—Shaft seal.
2,511,878 (Roots-Connersville Blower Corp.)—Screw Pump.
2,512,136 (Brown-Brockmeyer Co.)—Explosion-proof motor.
2,512,583 (P. S. McLean, F. L. Davis, and H. D. Flicker)—Rotary vane fluid pressure machine.
2,513,211 (Arthur P. Ruth)—Pumping unit.

Instruments

2,510,729 (Jergu son Gage & Valve Co.)—Liquid level indicating gage.
2,511,177 (Republic Flow Meters Co.)—Apparatus for the thermal conductivity type for measuring the composition of a gas.
2,511,276 (See Fabriks Aktiebolag, Sandviken, Sweden)—Equipment for measuring the thickness of tubes and the like.
2,511,392 (Thexton Mfg. Co.)—Electrical instrument for determining top dead center position in internal combustion engines.
2,511,399 (The Liquidometer Corp.)—Indicating instrument deactivation indication apparatus.
2,511,632 (Albion Henry Gregory, London, Eng.)—Liquid level meter.
2,511,649 (Frank J. Reiter)—Liquid level gage.
2,511,728 (Standard Oil Development Co.)—Mass spectrometer.
2,512,561 (Taylor Instrument Cos.)—Apparatus for exhibiting and/or controlling changes in a condition.
2,512,857 (William G. Gow)—Thermal conductivity gas cell.

Furnaces

2,512,319 (National Airoil Burner Co.)—Combustion apparatus for furnaces.
2,512,396 (Petro-Chem Process Co.)—Furnace cone of separable construction.

Storage Tanks

2,512,024 (American Pipe and Steel Corp.)—Head construction for horizontal liquefied petroleum tanks.
2,512,308 (Pittsburgh-Des Moines Co.)—Storage reservoir for liquefied gases.
2,513,181 (American Pipe and Steel Corp.)—Horizontal liquefied petroleum tanks.

Pipe and Fittings

2,511,158 (Thomas C. Gray)—Nonrigid pipe coupling.
2,511,386 (Chiksan Co.)—Seal for swivel joints.
2,512,745 (Worthington Pump & Machinery Corp.)—Expansion joint for heat exchangers.

Valves

2,511,435 (Clayton Mfg. Co.)—Vacuum breaker valve.
2,511,792 (Aero Supply Mfg. Co.)—Temperature controlled mixing valve, diaphragm type.

Miscellaneous

2,510,159 (Sol B. Wiezer)—Combination volumetric burette.
2,510,532 (Blair P. Udale)—Gas absorber, laboratory.
2,510,533 (Blair P. Udale)—Apparatus for gas analysis.
2,510,657 (Gilbert & Barker Mfg. Co.)—Liquid sampling device.
2,510,861 (Randolph Laboratories, Inc.)—Mobile fire extinguisher.
2,510,878 (The Texas Co.)—Device for applying stoppers to frangible objects, laboratory.
2,512,199 (Paragon Oil Co.)—Can and drum filling machine.
2,512,271 (Nathaniel P. Green)—Water-cooling tower.
2,512,456 (National Foam System, Inc.)—Foam-forming apparatus for fire extinguishment.

How to Obtain Patents

Readers may obtain copies of any U. S. patents from the Patent Office at 25 cents each. Order by patent number direct from the Commissioner of Patents, Washington 25, D. C.

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[To obtain more data on advertised products see page 882]

What do you look for when you buy chemicals?

No matter what you look for when you buy alkalies and associated chemicals . . . you'll find it when you *specify Solvay.*

In addition to price and specifications, Solvay offers the benefits of 69 years' experience with alkalies to assure you of finest quality. Solvay's five big plants, and more than 200 warehouse stock points from coast to coast guarantee prompt delivery.

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So why take less than the best? *Specify Solvay* and get all these advantages!

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[*To obtain more data on advertised products see page* 882]

Gasoline and Cycling Plant Operation

Conducted by DAVE THORNTON

The Questions and Answers presented here were transcribed from a wire recording of the popular "Information Please" session of the 29th Annual Convention of the Natural Gasoline Assn. of America in Fort Worth, April 26, 1950. Publication is made possible through the cooperation of the various authorities participating, W. F. Lowe, NGAA Secretary, and J. H. Dunn, The Shamrock Oil & Gas Co., Session Moderator.

Handling Two Gas Streams In a Single Absorber

In handling two gas streams, one of much lower gasoline content per thousand cubic feet than the other, is it practical to introduce the leaner gas higher into the absorber to increase the overall liquid recovery?

Yes, it is practical in some cases. As a matter of fact, we are successfully doing this at one of our plants. It reduces oil circulation and we secure higher recoveries of desired materials.

We are presently introducing up to 5000 Msfd. of a lean gas with approximately 0.75 gpm. of propane and heavier into the top third of our 30-tray, 250 psig. absorber, while handling up to 15,000 Mcfd. of a 13.0 gpm. gas through the entire column. The oil rate is set by a ratio controller proportionately to the flow of rich gas and no additional oil is required because of the lean gas.

By operating in this manner we are recovering more than 80% of the butanes and heavier in the lean gas and over 90% of the propane in the rich gas. To effect the same recoveries while mixing the two streams ahead of the absorber, it has been found necessary to use at least 20% greater oil circulation.—W. S. McAllister, Warren Petroleum Corp., Gladewater, Texas.

Results of Conservation Of Natural Gas in Texas

What has been the increase in the number of plants since the inauguration of the gas conservation program in Texas and what has been the results of these plants in increasing liquid hydrocarbons production since 1940?

The Texas conservation program on casinghead gas or gas that comes from oil wells really began in January, 1947. There were about 208 plants, which include gasoline, repressuring, pressure maintenance and dehydrating plants which were using natural gasoline to obtain the liquid hydrocarbons. As of January, 1950, there were 276 plants, an increase of about 68 plants.

The amazing thing on that increase is that during those years the number of plants which were pressure maintenance plants and repressuring plants rose from 70 to 105. In 1940 the state produced monthly about 2,300,000 barrels of liquid hydrocarbons which included distillates, natural gasoline, butanes, and propane from gas wells. The beginning of the program in 1947, liquid hydrocarbons rose to 5,800,000 bbls. a month. The last figure we have is of Feb. 1, 1950, there liquid hydrocarbons rore to 9,324,000 bbls. a month. So you can see that the main problem there is really in the liquid hydrocarbons which rose during the 10 years from 2,000,000 to 9,000,000 bbls. a month. —Jack K. Baumel, Oil & Gas Division, Railroad Commission of Texas, Austin.

Stress Corrosion in H_2S Removal Plants

What are some of the problems encountered in operating hydrogen sulfide removal plants?

Phillips has in operation hydrogen sulfide removal plants with capacities ranging from approximately 100 Mcfd. to 50 or 60,000 Mcfd. At some we simply sweeten the gas, removing hydrogen sulfide and with it part of the carbon dioxide. In others we also dry the gas by the use of glycol along with the amine. We have not had any particular difficulties with the operation.

The cycle and operating conditions used are quite standard but, during the past few years since the war, we have encountered considerable difficulty due to stress corrosion in these units. This is caused by decomposition products of the treating agent (amine). In any cases where we have not used stress-relieved vessels which are subject to high temperature and to the action of the treating agent, we have encountered failure of these vessels due to cracks in the metal.

Some of our engineers presented a paper on this subject at NGAA's Amarillo meeting last December, which was published just a few months ago (PETROLEUM PROCESSING Jan. 1950 p. 29-31—Ed.). This covered our troubles with stress corrosion quite thoroughly. Several very good photographs of the cracks we have found were presented, along with an excellent discussion. This is the principal difficulty we have had.

We do encounter some trouble due to having to re-run our treating agent to remove impurities caused by oxygen in the gas and carbon dioxide, which decomposition products (impurities) tend to build up and must be removed. In most of our units operating in the gasoline plants, we have taken care of this by the use of a small portable reclaimer which redistills the treating agent in a plant and then is moved on to the next plant. We do not reclaim continuously, although we do have under consideration, for one of our larger plants, a permanent reclaimer installation to continuously reclaim the treating agent.—H. R. Legatski, Phillips Petroleum Co., Bartlesville.

Safety Should be Made Part of Job Training

Does job training in plants hinder the safety program?

No, it does not, provided you put safety in your job training program. Your job is not finished if you only teach a man his job and how he is to operate a certain piece of machinery. You must at the same time teach him the safety aspects of his job. Too often, people are given a thorough training with emphasis only on the "how" of it. Then perhaps later on, they are given an intensive safety program in no way related to previous job training. That is wrong,

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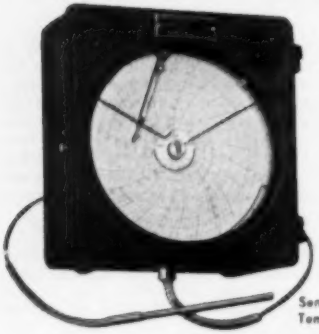

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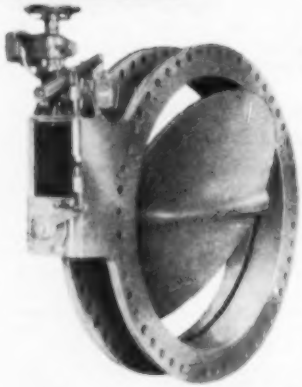

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and does hinder the safety program.

In other words, the man may learn how to operate a machine and when to do it, but he is not actually trained in the proper, safe method of doing that kind of work. For instance, if a man knows how to run a compressor but runs up and down the steps of the compressor in operating it, he unquestionably is *not* doing it the safe way.

The actions a man uses in carrying out the "how" of his job are important, particularly so when he first starts on the job. Such training is not a hindrance to the safety program, but a definite help.

We must get the "how" and the safety of the job closer together. Often they are too far apart. The safety responsibility rests directly with the immediate supervisor. The man who is teaching the how of any job should be advised by the safety representative. When he teaches a green hand that his job is such and such, he must emphasize that the safe way of doing it is as much a part of that job as any other part. This is good common sense and will help your training program.—D. A. Klemme, Stanolind Oil & Gas Co., Tulsa.

Shell's Safety Program

We have, as you know, an hazardous operation and in high pressure pipelining, where we are running up to 1200 and 1300 lbs. pressure, with volatile liquids like propane and butane, the safety angle is important.

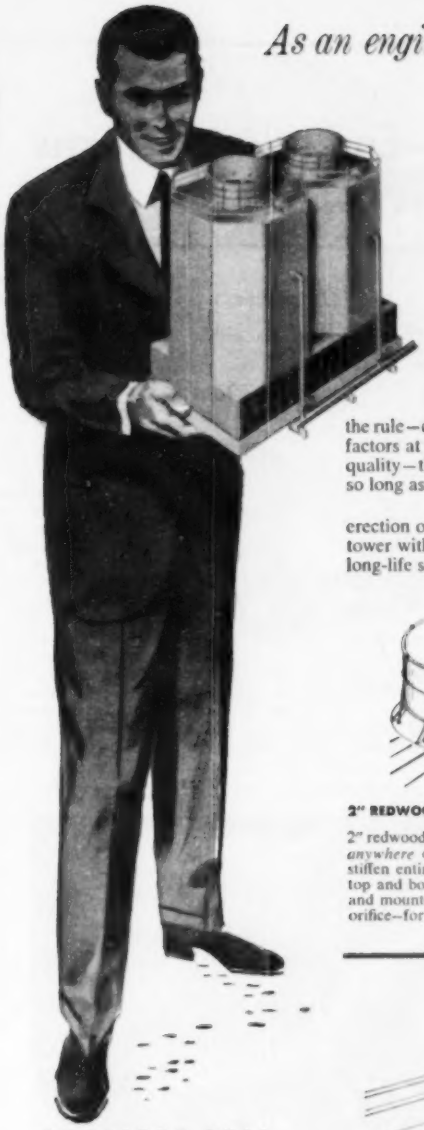
Safety starts with engineering, not with your men. One can design safe plants or unsafe plants; the real safety operation starts on the drafting board. Enough precautions can be placed in the average plant so that it is almost impossible for the man to foul up the operation by working in an unsafe manner. That leaves the safety training angle one of how the man handles himself—not the operation—and here I am at variance with most of the oil industry.

Safety training should *not* have a separate training schedule. It must be a part of job training and handled by the *same* people. I suggest this to any of you who are having difficulty with safety and your safety program:

Forget this business of sending out one man to teach the "how" of a job and then following up with another who tells the operator how not to do it. If you will put your safety training in the hands of the same people who handle job training, making it an important part of your business from the engineering through the operational training—through all the superintendents and right down to the man on the job—then safety becomes *no* problem.—S. S. Smith, Shell Oil Co., New York.

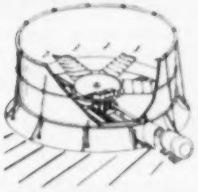
As an engineer you will appreciate...

The RUGGED DESIGN
inherent in the 1950
FLUOR COUNTERFLO
Cooling Tower



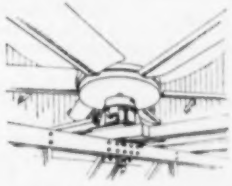
Ruggedness is a prerequisite in cooling tower design and performance. Without it, inefficiency and costly maintenance becomes the rule—drop in plant production is the end result. Regardless of the influencing factors at time of purchase—low first cost, claims of efficiency or statement of quality—the cooling tower you select will meet performance requirements *only* so long as its original structural design endures.

Thirty years' intensive development in the design, fabrication and erection of cooling towers enables Fluor to offer you a better cooling tower—a tower with comparable first cost, the highest obtainable efficiency and rugged, long-life service.



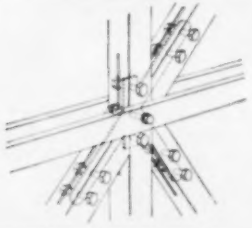
2" REDWOOD IN FAN DECK and STACK

2" redwood supports 1000#/sq. ft. load *anywhere* on deck—heavy enough to stiffen entire structure. Stack is ringed top and bottom with heavy angle iron and mounted on a metal bell-mouthed orifice—for safety and savings in power.



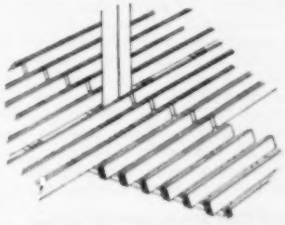
RUGGED GEAR UNIT and FAN BLADES

Gear unit is designed *specifically* for cooling tower service. Result: Less than ¼ of 1% replacement parts! Heavy Stainless Steel Fan Blades give a larger moment of inertia—tips are strong enough to hold a man's weight.



STRONGER STRUCTURAL DESIGN

Internal gusset plate and bolt-type joints enable structural members to take *both* tension and compression loads—a design *in accordance* with the rigid requirements of major city codes and recent findings of the U. S. Forest Products Laboratory.



1" REDWOOD GRID DECK FILLING

Grid decks consist of heavy 1" redwood nailed individually on sturdy cleats—strong enough for use as scaffolding during tower erection, durable enough to permit repeated removal for cleaning or fire hosing without removing from tower.

CONSIDER THIS
about
"Guaranteed Performance"

Fluor's "Guarantee of Performance" is based on a true bid to meet specified performance requirements. There is an old saying, "You can't get something for nothing." This is particularly true in the purchase of cooling towers—a bid allowing performance to be off only 2 or 3 degrees on the approach may seem insignificant at time of purchase, but it can mean as much as 30 to 40% difference in the size of tower necessary to do the specified job! Often this is overlooked if a tower is purchased on price alone.

For your protection compare the probable performance of the towers offered before making a decision. Analyze your cooling tower bids thoroughly!

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NEWS OF

Manufacturers—Suppliers—Engineering Firms

Serving the Petroleum Processing Industry

Forms New Refinery Fittings Firm

Burkhart Engineering Co., with offices at 1221 Locust St., St. Louis, Mo., has been established to design and manufacture petroleum refinery fittings. Merle E. Burkhart, president, is a registered professional mechanical engineer in Missouri. He was with Key Co., East St. Louis, Ill., as chief engineer from 1937 to 1940; vice president in charge of engineering, 1940-1945; and vice president in charge of sales, 1945.

Mr. Burkhart

In 1945, he joined the K. P. Wesseling Co., machinery dealer. Incorporators of the new firm include Mr. Burkhart, Mr. Wesseling, and Mr. H. H. Stern. Sales manager of the West Coast office, 6738 Hollywood Blvd., Hollywood, Calif., is H. Schlarman.

Atlas Mineral Makes Appointments

Atlas Mineral Products Co., Mertztown, Penna., has announced the following personnel changes.

Richard A. Weppner, formerly with Pennsylvania Salt Mfg. Co., has been appointed sales engineer in Delaware, Maryland, Virginia, and parts of West Virginia and New Jersey. Philip E. Berens, recently in Detroit for Atlas, has been made sales representative in Eastern Pennsylvania, Western New York, and parts of New Jersey. William A. Streaker, previously associated with General Electric, is now sales engineer in the lower peninsula of Michigan, Eastern Indiana, and Lucas County in Ohio.

B&W Tube Builds Extrusion Plant

A new million-dollar extrusion plant for fabricating tubes of ferrous metals and alloys in complex sectional shapes will be built in Beaver Falls by the Babcock & Wilcox Tube Co. The announcement followed the completion of a licensing agreement between B&W and Comptoir Industrial d'Etirage & Profilage de Metaux of Paris, France, developers of the process and holders of the patent rights.

The process offers a method of fabricating alloys which are difficult or impossible to fabricate by the rolling or forging methods in use today.

Fisher Buys Tagliabue Line

Complete test equipment for the petroleum laboratory can now be obtained from Fisher Scientific Co., Pittsburgh. The acquisition of the complete stocks, tools, dies, and full rights to equipment developed by the C. J. Tagliabue Co. of Newark, N. J., was announced recently by Fisher's president, Aiken W. Fisher. Instruments will be marketed under the trade-name Fisher-Tag.

Exchanger Makers Elect Officers

C. H. Currier, president of Ross Heater & Mfg. Co., Buffalo, was elected president at the annual meeting recently of the Tubular Exchanger Manufacturing Association, Inc., at Skytop, Penna. W. C. Beckley, president of Whitlock Mfg. Co., Hartford, Conn., was elected TEMA vice president.

The following comprise the executive committee: T. H. Miley, Foster Wheeler Corp.; G. A. Worn, The Lummus Co.; and Messrs. Currier and Beckley. Permanent offices of the TEMA are at 53 Park Place, New York 7, N. Y.

Oakite Places Hudson in Dallas

Mr. Hudson

Oakite Products, Inc., has appointed J. D. Hudson to its petroleum service division staff, to operate from offices in Dallas. Mr. Hudson, a graduate of Mississippi State with graduate work at M.I.T., entered the refinery construction business in the Louisiana area in 1935. In 1943 he joined Cities Service at Lake Charles, remaining with that organization until his appointment by

Du Pont Inaugurates Nation-wide Tour for Three Gasoline Test Cars

A group of three "laboratories-on-wheels" have been put on the road on a 15,000-mile tour of the country by Du Pont's Petroleum Chemicals Division to bring a scientific story of what makes a good automobile fuel to refining, marketing, and research groups of the automotive and petroleum industries. The trunk compartment of each car (see picture above) holds 10 auxiliary fuel tanks: four for test fuels and six for reference fuels of octane number from 80 to 92.5. A battery of pushbuttons on an especially designed instrument panel at the driver's seat controls operation of the motor on any desired fuel. The panel includes the usual instruments for checking engine operation as in any conventional road test car. The three cars will be on tour until Christmas, 1950.

NEW DIANODIC METHOD OF COOLING WATER TREATMENT

Here's an entirely new approach for the prevention of corrosion, pitting and scale in cooling water systems. The dianodic method was developed in the research laboratory and proved in the field. Amazing results are obtainable—Freedom from Scale, Protection against Corrosion, and ELIMINATION OF PITTING AND TUBERCULATION.

Basically, the dianodic method consists in employing a combination of two anodic inhibitors in such a manner as to produce results superior to either inhibitor singly—*even in high concentrations.* With the proper use of conventional inhibitors it is possible to obtain good overall corrosion protection, but localized corrosion may continue to occur in the form of pitting. In these areas of concentrated attack, corrosion may be accelerated so that metal failure is almost as rapid as without any corrosion inhibitor. The new dianodic method gives equal or better protection from the standpoint of general corrosion and ELIMINATES PITTING AND TUBERCULATION.

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A complete report on the Dianodic Method of cooling water treatment. Ask for Technical Paper No. 120.

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BETZ

BOILER WATER CONDITIONING • COOLING WATER CONDITIONING • INDUSTRIAL WASTE TREATMENT

Oakite. He will assist the company's field representatives on special problems in connection with petroleum industry cleaning and allied operations.

Farris Buys Edison Stacon

Farris Engrg. Corp., has recently announced the formation of a company to purchase the Edison Stacon Regulating Valve Division from Thomas A. Edison, Inc. (Instrument Division). The company has acquired all the Stacon patents, equipment, machinery, inventory, and records, and will serve present users of Stacon products. The new company will be known as the Farris Stacon Corp., with main office and plant located in Palisades Park, N. J.

Walton Joins Petroleum Processing

Mr. Walton

Jack Walton has been appointed sales representative for PETROLEUM PROCESSING in the Ohio, Michigan, Western Pennsylvania and Northern New York territory. He replaces Steve Steiner, who retired recently. Mr. Walton has been associated with the Simmons-Boardman Publishing Corp. for the past five years, as sales representative for their railroad and marine publications.

Hammond Iron Opens Bristol Plant

Hammond Iron Works, with main plant at Warren, Penna., have opened a new fabricating plant at Bristol, Penna., between Philadelphia and New York. Comprising 16 acres, with a main line railroad siding, and near deep-water docks for marine transportation, the plant almost doubles Hammond's original fabricating capacity. A feature of the new equipment is a planer with a 60-ft. bed for gang planing the largest size steel plates.

H. R. Jones Goes to Blaw-Knox

The Chemical Plants Division of Blaw-Knox Construction Co., Pittsburgh, has appointed Dr. H. Roswell Jones to the synthetic fuels and chemicals department. Dr. Jones will be engaged mainly in design of plants to produce finished products from Fischer-Tropsch, Oxo, and Oxyl syntheses. He has had wide experience in petroleum refining before coming with Blaw-Knox.

Personnel Changes

American Meter Co.—Alexander B. Cloud, with the organization since 1936 in production, service, and sales work, has been named district sales manager in New York.

Spencer Chemical Co.—George V. Taylor, director of market research since 1947, has been promoted to director of sales development.

Atlas Mineral Products Co.—Edison C. Sickman, former Baltimore district sales manager, has been appointed general sales coordinator. R. R. Graver has become associated with the engineering department, and G. F. Gilbert, Jr., has accepted a position as assistant to the technical director.

Southwestern Engrg. Co.—R. V. Gunther, with the firm eight years and most recently senior engineer, has been advanced to assistant production manager, manufacturing division. L. G. Janzow, who was promoted to chief engineer of that division, started in 1936 and had been design engineer. James F. Geary has joined SWECO as chief engineer of the construction division.

Peabody Engrg. Corp.—Allen H. Jones has been named manager of the newly-opened office in Chicago.

Republic Supply Co.—J. H. Lollar, Jr., has assumed the duties of president, and H. B. Catlow, vice president in charge of sales, effective July 1. Both men continue to serve on the board of directors.

General Refractories Co. — Harry T. Graham has been appointed general sales manager, and S. S. Furst, formerly holding that position, has been appointed assistant to the vice president in charge of sales. Mr. Graham has been with the company since 1937.

Tube Turns, Inc.—Landis O. Morris, Jr., who joined the firm in July, 1949, has been assigned to the staff of Robert S. Tyler, Jr., manager of the Tulsa office.

Penn Industrial Instrument Co.—James W. Bennett, for the past five years associated with Energy Control Co. in New York, has been appointed general sales manager for Penn, with headquarters in the main offices in Philadelphia.

Fairbanks, Morse & Co.—Two new vice presidents were elected at a recent meeting of the board of directors. O. O. Lewis is now vice president in charge of sales, and F. J. Heaslip, vice president in charge of purchases and traffic.

L. Sonneborn Sons, Inc.—Robert J. Sandke and William F. Greenwald have been named co-managers of West Coast sales of petroleum products. L. B. Benjamin, who has represented Sonneborn on the West Coast for several years, will devote his activities to sales of products for building construction and maintenance.

Branches, Distributors

Union Asbestos & Rubber Co. has named **The Aber Co., Inc.,** as distributors in the Southwest for their industrial insulations. Aber maintains offices in Houston, Shreveport, New Orleans, Amarillo, and Tulsa. Product requirements will be met by the new UNARCO plant at McGregor, Texas.

Alloy Steel Products Co., Inc., Linden, N. J., has appointed **S. W. Collins** sales representative for Oklahoma and Kansas, with offices at 419 Ritz Bldg., Tulsa 5, Okla. Mr. Collins recently returned to the Mid-continent area from New York where he had represented Pacific Valve Co. Prior to that he had been assistant district manager in Oklahoma for the Oklahoma Refinery and Machinery Co.

W. H. Brady Co. has moved its Milwaukee office from 808 North Third St. to 204 West Washington St., Milwaukee 4. The new telephone number is EVergreen 4-4800.

Expansion, Transition

National Technical Laboratories, Los Angeles, has changed its corporate name to Beckman Instruments, Inc. This action was taken for the purpose of associating the corporate name more closely with the trademark of the firm's principal products. No changes were involved in organization, policies, personnel, products, or locations of factory and service branches in New York, Chicago, and South Pasadena, Calif.

The controlling interest of the **Leader Iron Works Co.,** 2100 N. Jasper St., Decatur, Ill., has been acquired by Julius H. Peters, formerly associated with **Colonial Iron Works Co.,** Cleveland. Leader specializes in manufacture of large steel and alloy processing equipment, and storage tanks. Normal employment is about 120.

R. S. Aries & Associates has moved its executive offices to 400 Madison Ave., New York 17, from 26 Court St., Brooklyn. General engineering offices and drafting rooms will remain at the old address. Telephone numbers of the new office at 47th and Madison are ELdorado 5-1430-1-2-3.

ALCOA

ALUMINUM

Alcoa Heat Exchanger News

PUBLISHED BY THE ALUMINUM COMPANY OF AMERICA

HOW TO SAVE UP TO 80% ON TUBES

You can prove this to yourself. Check your local supplier—get his prices on tubes of all metals—then compare with Alcoa Aluminum Tube prices at the retail level. Foot for foot, metal for metal, you'll find Alcoa Tubes cutting your costs 30%, 50%, even 80%—depending on the type of tubes you now use. Many medium-sized refineries save $50,000 every year by switching to Alcoa Tubes.

Alcoa Tubes resist the hydrocarbons, hydrogen sulfide and carbon dioxide present in refinery products—as well or better than other metals. Records of 15, 20, even 25 years' continuous use are not unusual for Alcoa Tubes in heat exchanger service. Many of these case histories are available for your inspection.

Alcoa Tubes allow you a wide range of operating temperatures. They easily handle steam up to 400°F. They increase in strength and show no evidence of embrittlement as temperatures drop to −320°F and below. Using Alclad Tubes, you'll have no problems from most cooling waters.

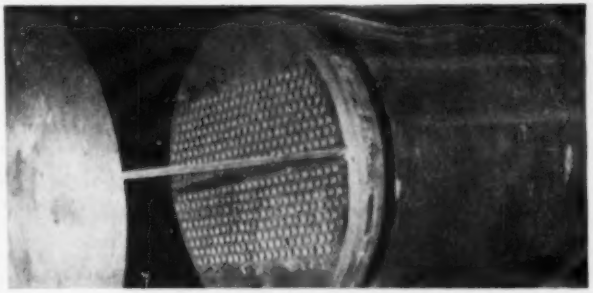
Roll-in, expanding and other fabrication go faster with Alcoa Tubes. Your present tools and techniques will do the job. Aluminum is easy to machine and to weld.

For complete information and the name of your nearest supplier, call your local Alcoa sales office. Or write: ALUMINUM COMPANY OF AMERICA, 1493H Gulf Building, Pittsburgh 19, Pennsylvania.

* * *

ALCOA OFFERS NEW BOOK

This new, 24-page booklet will answer many of your questions about Alcoa Tubes. It covers fabrication techniques . . . alloy selection . . . applications both chemical and petroleum. It describes tube cleaning, the use of inhibitors and methods of cathodic protection. It contains complete information on fluid flow and heat transfer characteristics, plus tables of physical properties and specification data. Write for your free copy, today. ALUMINUM COMPANY OF AMERICA, 1493H Gulf Building, Pittsburgh 19, Pennsylvania.



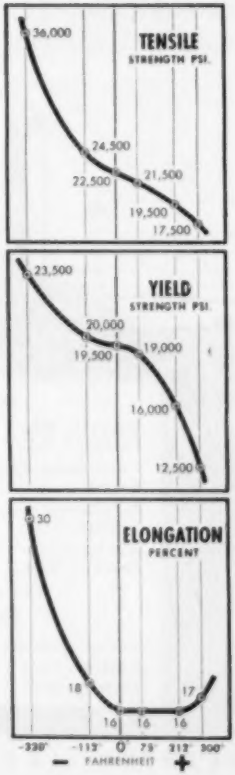
An all-aluminum heat exchanger for tonnage oxygen plant —designed and built by Stacey Bros. Gas Construction Co.

ALUMINUM TUBES EXCEL IN SUB-ZERO PROCESSING

When your process calls for temperatures down to −320°F—and your service conditions call for utmost strength—specify Alcoa Tubes. 3S alloy, for example, improves 67% in tensile strength, 23% in yield strength and more than 80% in elongation as temperatures drop from 75°F to −320°F.

The high thermal conductivity of aluminum increases the efficiency of many types of exchangers and condensers. And best of all, Alcoa Aluminum Tubes cost far less to buy and fabricate than any other suitable metals.

Complete information is available on Alcoa Tubes for tonnage oxygen, natural gas liquefaction, nitrogen removal, dewaxing, propane chilling, ethylene extraction and many other low-temperature processes. Call your local Alcoa sales office or write: ALUMINUM COMPANY OF AMERICA, 1493H Gulf Building, Pittsburgh 19, Pa.



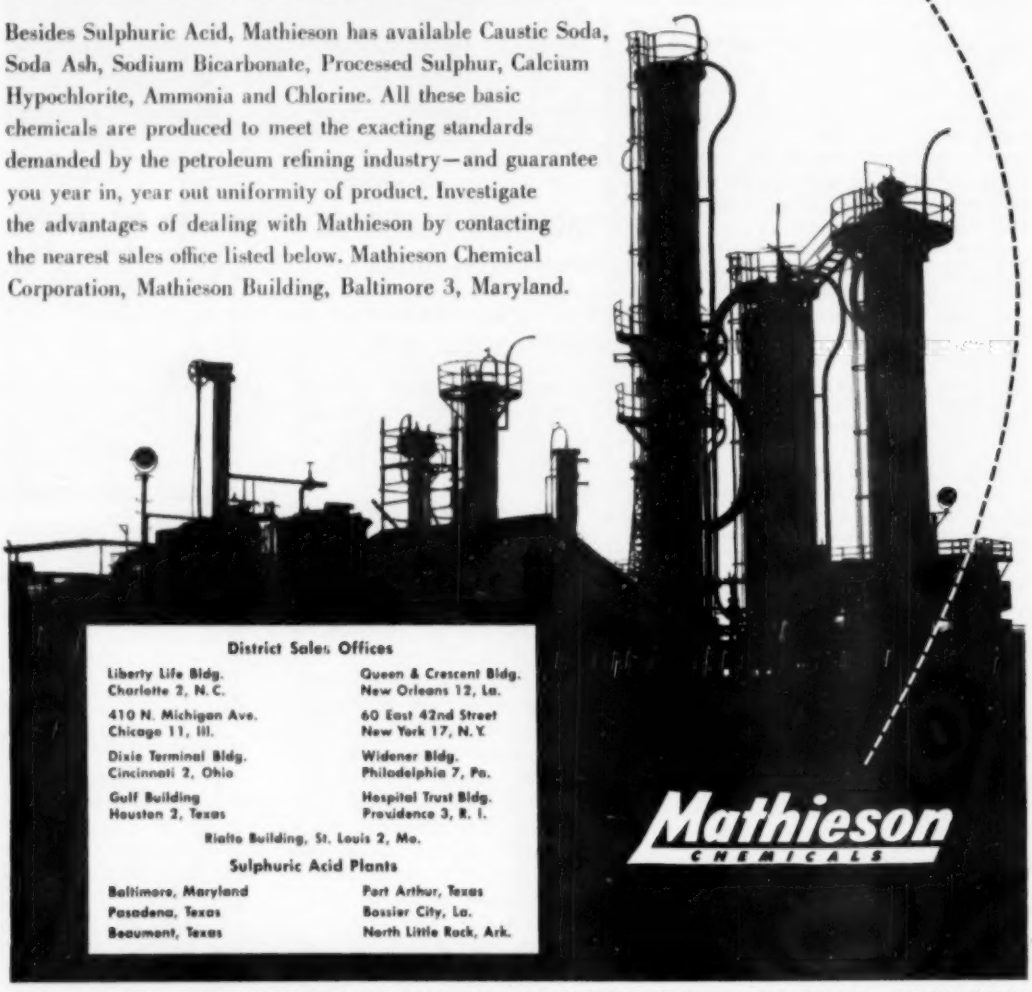
These three graphs show the amazing increase in tensile properties of aluminum as temperatures drop below zero.

[To obtain more data on advertised products see page 882]

MATHIESON . . . *a dependable source of basic chemicals . . . including* **sulphuric acid**

● You can depend on Mathieson as a reliable source of the most basic of all heavy chemicals—Sulphuric Acid. With six major producing plants, strategically located, Mathieson is in a position to give you prompt deliveries economically.

Besides Sulphuric Acid, Mathieson has available Caustic Soda, Soda Ash, Sodium Bicarbonate, Processed Sulphur, Calcium Hypochlorite, Ammonia and Chlorine. All these basic chemicals are produced to meet the exacting standards demanded by the petroleum refining industry—and guarantee you year in, year out uniformity of product. Investigate the advantages of dealing with Mathieson by contacting the nearest sales office listed below. Mathieson Chemical Corporation, Mathieson Building, Baltimore 3, Maryland.



District Sales Offices

Liberty Life Bldg.
Charlotte 2, N. C.

Queen & Crescent Bldg.
New Orleans 12, La.

410 N. Michigan Ave.
Chicago 11, Ill.

60 East 42nd Street
New York 17, N. Y.

Dixie Terminal Bldg.
Cincinnati 2, Ohio

Widener Bldg.
Philadelphia 7, Pa.

Gulf Building
Houston 2, Texas

Hospital Trust Bldg.
Providence 3, R. I.

Rialto Building, St. Louis 2, Mo.

Sulphuric Acid Plants

Baltimore, Maryland

Port Arthur, Texas

Pasadena, Texas

Bossier City, La.

Beaumont, Texas

North Little Rock, Ark.

Mathieson
CHEMICALS

SERVING INDUSTRY, AGRICULTURE AND PUBLIC HEALTH

REFINING TRENDS

Large Demand, Additions to Storage Bring Crude Runs to All-Time High

IF the Korean war made an impact on U. S. refiners in July it was only in conjunction with high domestic product demand, and additions to storage, to bring crude runs to an indicated 5,825,000 b/d for the first three weeks of the month. This is the highest volume on record, but was approached closely in December, 1948. Total runs went to over 5,900,000 b/d in the early part of July but dropped off later in the month. The Bureau of Mines' forecast for runs to stills in August is 5,780,000 bbls.

Indicated demand at refineries for all products in July was considerably higher than for July a year ago. Demand for motor fuel was at the rate of over 3,100,000 b/d, while the peak demand in 1949 was 2,895,500 b/d avg. in June. Drafts on stocks brought the total as of the end of July to under the total of 111,200,000 bbls. in storage July 31, 1949. See Fig. 3.

Refiners' ideas on product inventories have changed since the outbreak of the war in Korea. Until then it was felt that the level of 133,700,000 bbls. of gasoline storage at the end of March this year was higher than actually required and the effort might not have been made this fall and winter to build up to this level. A stock level higher than normally needed, of other products as well as gasoline, now could be looked upon as a cushion against a later emergency need, the maximum volume held being dependent chiefly on available storage.

Crude Runs—Indicated rate of runs in July was around 12% higher than in July a year ago. Increased operations the past two or three months have brought total runs for 6 months of 1950 to above the total for 6 months of 1949. Runs of domestic crude are but slightly higher, while runs of foreign crude are 15% higher.

Motor Fuel—Indicated refinery production of motor fuel for 6 months has been 2% larger than for the first 6 months of 1949, and the increasing use of natural gas liquids brings the total motor fuel supply for 6 months to 3% larger than a year ago. However, the indicated rate of production of motor fuel in July was nearly 8% larger than for July, '49. Indicated motor fuel demand in July is about 14% ahead of demand in July, '49 while demand for 6 months is 4.8% higher than a year ago.

Heating Oils—The present rate of heating oil production (kerosine and distillates) at refineries is such that, although demand continues much higher than in the same weeks in 1949, stocks are being built up faster in 1949. The indicated total on July 31st was around 85,000,000 bbls., a buildup of around 34,000,000 bbls. from March 31st. Last year heating oils stocks were 96,380,000 bbls. on July 31st, having built up from 66,725,000 bbls. March 31st of that year.

The East Coast area, the largest supplier of heating oils among the various refining districts, on June 30th had only about two-thirds the volume of heating oils in storage as on that date in 1949. Table 1 shows stocks of heating oils by districts for the two dates.

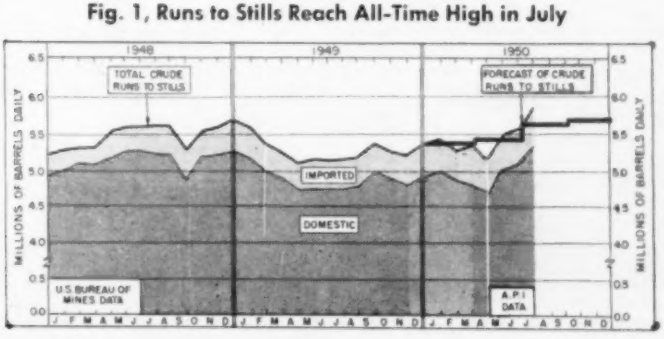
Residual Fuels—Indicated supply in July is considerably increased from July a year ago, due to higher rate of imports. Refinery output of this product is ahead of that of a year ago for the first time in 1950. Indicated demand for residuals is nearly 14% ahead of July a year ago.

Residual fuel oil stocks east of California this year have increased from around 19,500,000 bbls. March 31 to an indicated approximate 26,000,000 bbls. July 31st.

TABLE 1—Stocks of Heating Oils, June 30, 1949-1950 (1000 Bbls.)

Refining District	June 30, 1949 Kerosine	June 30, 1949 Distillate	June 30, 1949 Total	June 30, 1950 Kerosine	June 30, 1950 Distillate	June 30, 1950 Total
East Coast	9,790	21,028	30,818	7,176	13,652	20,828
Gulf Coast	5,710	14,011	19,721	6,118	11,392	17,510
Inland						
Appalach.	565	905	1,470	499	788	1,287
Ind.-Ill.-Ky.	4,056	10,208	14,264	3,976	7,957	11,933
Southwest	2,398	6,643	9,041	1,941	6,490	8,431
Rocky Mts.	334	1,514	1,848	407	1,410	1,817
Total Inland	7,353	19,270	26,623	6,823	16,645	23,468
U. S. except Cal.	22,853	54,307	77,160	20,117	41,689	61,806
California	795	10,423	11,218	960	11,254	12,130
Total U. S.	23,648	64,730	88,378	21,077	52,943	73,936

Fig. 1, Runs to Stills Reach All-Time High in July


1948
1949
1950
TOTAL CRUDE RUNS TO STILLS
FORECAST OF CRUDE RUNS TO STILLS
IMPORTED
DOMESTIC
U.S. BUREAU OF MINES DATA
A.P.I. DATA
MILLIONS OF BARRELS DAILY
J F M A M J J A S O N D J F M A M J J A S O N D J F M A M J J A S O N D

Crude Runs to Stills

Daily Average (1000 bbls.)

	Domestic	Foreign	TOTAL
July '50 API*	5,339	495	5,826
July '49 API	4,747	426	5,173
Change	+.583	+.79	+.653
% Change	12.3	16.9	12.6

* Through July 22.

Total (1000 bbls.)
(Bureau of Mines Data)

6 Mo. '50*	835,817	81,096	972,913
6 Mo. '49	891,126	73,665	964,791
Change	+4,691	+10,431	+15,122
% Change	0.5	14.2	1.6

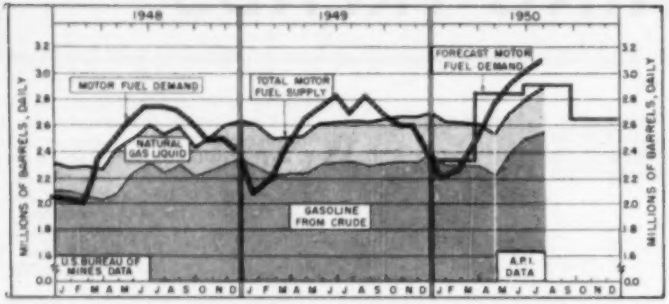
* May and June from API data.

BM Forecast of Runs to Stills
(1000 b/d avg.—Revised in June)
3rd Quar., 5,610; 4th Quar., 5,650; 1950, 5,514

Yields on Crude Runs to Stills

	Gasoline %	Kerosine %	Dist. Fuels %	Resid. Fuels %
July '50 API	43.8	4.7	17.7	19.5
June '50 API	44.4	5.2	18.9	19.0
May '50 API	43.8	5.6	18.6	19.3
July '49 BM	45.7	4.4	16.2	20.1

Fig. 2, Sharp Rise in Motor Fuel Supply-Demand


1948
1949
1950
MOTOR FUEL DEMAND
TOTAL MOTOR FUEL SUPPLY
FORECAST MOTOR FUEL DEMAND
NATURAL GAS LIQUID
GASOLINE FROM CRUDE
U.S. BUREAU OF MINES DATA
API DATA
MILLIONS OF BARRELS, DAILY
J F M A M J J A S O N D J F M A M J J A S O N D J F M A M J J A S O N D

*Natural Gas Liquids include natural gasoline blended at refineries and used direct as motor fuel.

Fig. 3, Gasoline Stocks Below July, 1949

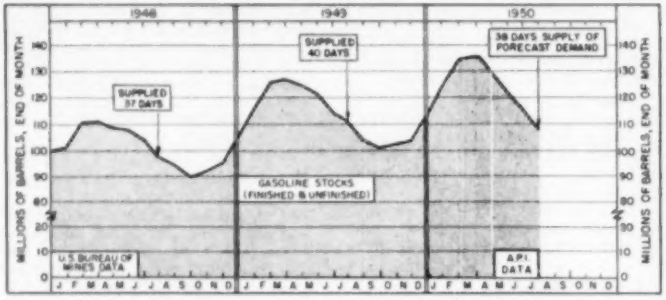

1948
1949
1950
SUPPLIED 37 DAYS
SUPPLIED 40 DAYS
38 DAYS SUPPLY OF FORECAST DEMAND
GASOLINE STOCKS (FINISHED & UNFINISHED)
U.S. BUREAU OF MINES DATA
API DATA
MILLIONS OF BARRELS, END OF MONTH
J F M A M J J A S O N D J F M A M J J A S O N D J F M A M J J A S O N D

Fig. 4, No Seasonal Drop in Heating Oil Output

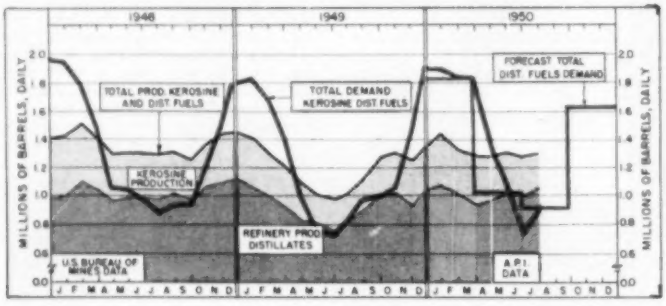
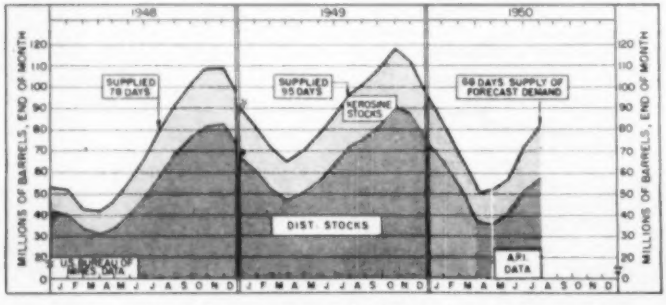

1948
1949
1950
TOTAL PROD. KEROSINE AND DIST. FUELS
TOTAL DEMAND KEROSINE DIST. FUELS
FORECAST TOTAL DIST. FUELS DEMAND
KEROSINE PRODUCTION
REFINERY PROD. DISTILLATES
U.S. BUREAU OF MINES DATA
API DATA
MILLIONS OF BARRELS, DAILY
J F M A M J J A S O N D J F M A M J J A S O N D J F M A M J J A S O N D

Fig. 5, Sharp Buildup in Heating Oils Stocks


1948
1949
1950
SUPPLIED 78 DAYS
SUPPLIED 95 DAYS
KEROSINE STOCKS
68 DAYS SUPPLY OF FORECAST DEMAND
DIST. STOCKS
U.S. BUREAU OF MINES DATA
API DATA
MILLIONS OF BARRELS, END OF MONTH
J F M A M J J A S O N D J F M A M J J A S O N D J F M A M J J A S O N D

*Change in reporting in California eliminated 4,500,000 bbls. from distillate classification.

Motor Fuel Supply

Daily Average (1000 bbls.)

	Gasoline from Crude	Natural Blended Used Direct	TOTAL
July '50 API*	2,550	335	2,885
July '49 BM	2,379	297	2,676
Change	+171	+38	+209
% Change	7.2	12.8	7.8

* Through July 22.

Total (1000 bbls.)
(Bureau of Mines Data)

6 Mo. '50*	436,765	56,676	493,781
6 Mo. '49	417,458	52,465	469,863
Change	+9,247	+3,671	+12,918
% Change	2.2	7.0	2.9

* May and June from API data.

Motor Fuel Demand

Including Exports
Daily Average (1000 bbls.)

July '50 API*	3,125
July '49 BM	2,729
Change	+396
% Change	14.6

* Through July 22.

Total (1000 bbls.)
(Bureau of Mines Data)

6 Mo. '50*	479,858
6 Mo. '49	457,824
Change	+22,034
% Change	4.8

* May & June from API data.

BM Forecast of Motor Fuel Demand
(1000 b/d avg.—Revised in June)
3rd Quar., 2,892; 4th Quar., 2,674; 1950, 2,712

Gasoline Stocks

Finished and unfinished, end of month (1000 bbls.)

July '50 API*	108,912
June '50 API	114,276
May '50 API	121,897
July '49 BM	111,217

* On July 22.

Heating Oils Production

(Kerosine and Distillates)
Daily Average (1000 bbls.)

	Kerosine	Dist. Fuels	TOTAL
July '50 API*	275	1,035	1,310
July '49 BM	225	835	1,060
Change	+50	+200	+250
% Change	22.2	24.1	23.6

* Through July 22.

Total (1000 bbls.)
(Bureau of Mines Data)

6 Mo. '50*	57,866	181,744	239,610
6 Mo. '49	50,543	163,746	214,289
Change	+7,323	+17,998	+25,321
% Change	14.5	11.0	11.8

* May and June from API data.

Heating Oils Demand

Daily Average (1000 bbls.)

	Kerosine	Dist. Fuels	TOTAL
July '50 API*	198	740	938
July '49 BM	187	628	815
Change	+11	+112	+123
% Change	5.8	17.8	15.1

* Through July 22.

Total (1000 bbls.)
(Bureau of Mines Data)

6 Mo. '50*	59,110	206,751	265,867
6 Mo. '49	50,790	172,609	223,399
Change	+8,320	+34,142	+42,468
% Change	16.4	19.7	19.0

* May and June from API data.

BM Forecast of Heating Oil Demand
(1000 b/d avg.—Revised in June)
3rd Quar., 967; 4th Quar., 1,085; 1950, 1,386

Heating Oil Stocks

(1000 bbls. end of month)

	Kerosine	Dist. Fuels	TOTAL
July '50 API*	22,766	59,434	82,200
June '50 API	21,077	52,938	74,015
May '50 BM	17,304	43,739	60,943
July '49 BM	24,826	71,553	96,379

* July 22.

Fig. 6, Residuals Demand Continues Strong

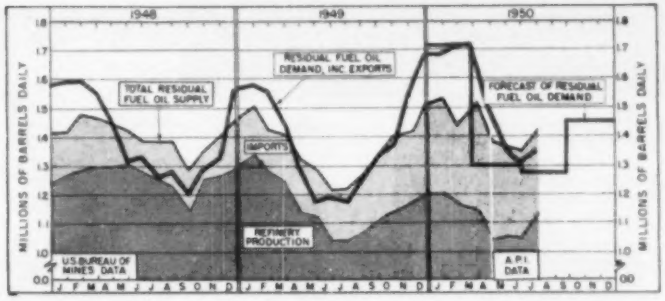
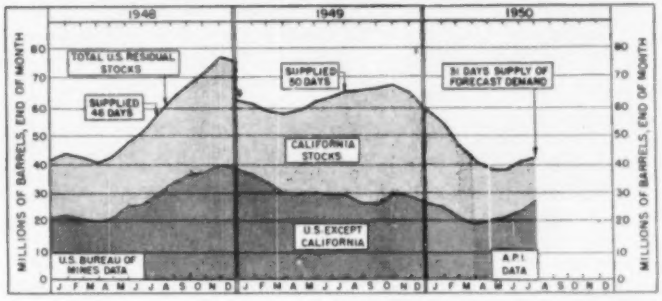

1948
1949
1950
MILLIONS OF BARRELS DAILY
TOTAL RESIDUAL FUEL OIL SUPPLY
RESIDUAL FUEL OIL DEMAND, INC. EXPORTS
FORECAST OF RESIDUAL FUEL OIL DEMAND
IMPORTS
REFINERY PRODUCTION
U.S. BUREAU OF MINES DATA
A.P.I. DATA
J F M A M J J A S O N D J F M A M J J A S O N D J F M A M J J A S O N D

Fig. 7, Slow Buildup in Residuals Stocks


1948
1949
1950
MILLIONS OF BARRELS, END OF MONTH
TOTAL U.S. RESIDUAL STOCKS
SUPPLIED 46 DAYS
SUPPLIED 50 DAYS
36 DAYS SUPPLY OF FORECAST DEMAND
CALIFORNIA STOCKS
U.S. EXCEPT CALIFORNIA
U.S. BUREAU OF MINES DATA
A.P.I. DATA
J F M A M J J A S O N D J F M A M J J A S O N D J F M A M J J A S O N D

*Change in reporting in California eliminated 13,000,000 bbls. from residual classification.

Residual Fuels Production

Daily Average (1000 bbls.)

	Refinery Output	Imports	TOTAL
July '50 API*	1,140	296	1,436
July '49 BM	1,860	184	1,324
Change	+100	+100	+296
% Change	9.6	27.6	16.8

* Through July 23.

Total (1000 bbls.)
(Bureau of Mines Data)

6 Mo. '50*	202,647	56,953	259,600
6 Mo. '49	217,811	30,232	248,043
Change	−15,164	+26,721	+11,557
% Change	6.9	88.3	4.6

* May and June from API data.

Residual Fuels Demand

Daily Average (1000 bbls.)

July '50 API*	1,350
July '49 BM	1,189
Change	+161
% Change	13.6

* Through July 22.

Total Demand (1000 bbls.)

6 Mo. '50*	289,851
6 Mo. '49	250,124
Change	+39,727
% Change	15.9

* May and June from API data.

BM Forecast of Residual Fuel Demand
(1000 b/d avg.—Revised In June)
3rd Quar., 1,293; 4th Quar., 1,467; 1950, 1,449

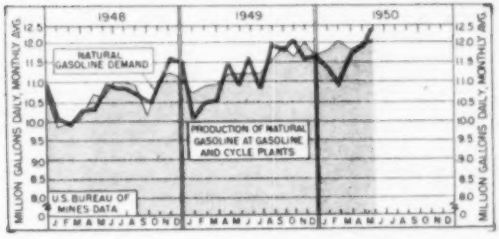
Residual Fuel Stocks

1000 bbls. end of month

	U.S. Except California	Total U.S.
July '50 API*	25,527	42,424
June '50 API	25,038	40,649
May '50 BM	21,100	39,482
July '49 BM	29,133	66,084

* July 22.

Fig. 8, Production and Demand of Natural Gas Liquids


1948
1949
1950
MILLION GALLONS DAILY MONTHLY AVG.
NATURAL GASOLINE DEMAND
PRODUCTION OF NATURAL GASOLINE AT GASOLINE AND CYCLE PLANTS
U.S. BUREAU OF MINES DATA
J F M A M J J A S O N D J F M A M J J A S O N D J F M A M J J A S O N D

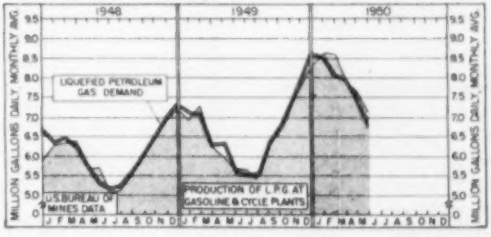
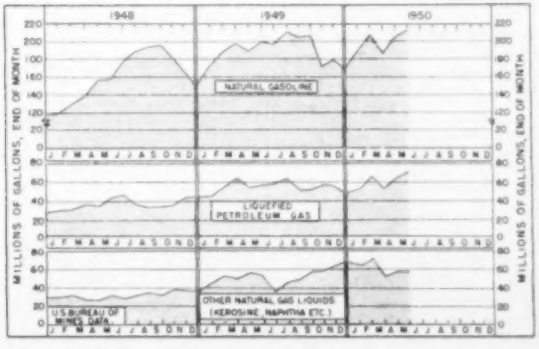

1948
1949
1950
MILLION GALLONS DAILY MONTHLY AVG.
LIQUEFIED PETROLEUM GAS DEMAND
PRODUCTION OF L.P.G. AT GASOLINE & CYCLE PLANTS
U.S. BUREAU OF MINES DATA
J F M A M J J A S O N D J F M A M J J A S O N D J F M A M J J A S O N D

Fig. 9, Stocks of Natural Gas Liquids


1948
1949
1950
MILLIONS OF GALLONS, END OF MONTH
NATURAL GASOLINE
LIQUEFIED PETROLEUM GAS
OTHER NATURAL GAS LIQUIDS (KEROSINE, NAPHTHA ETC.)
U.S. BUREAU OF MINES DATA
J F M A M J J A S O N D J F M A M J J A S O N D J F M A M J J A S O N D

Natural Gas Liquids Statistics

(Source: U. S. Bureau of Mines Report on Natural Gasoline and Cycle Plant Operations)

	Production (1000 gal./day avg.) Natural Gasoline	LPG**	TOTAL	Demand* (1000 gal./day avg.) Natural Gasoline	LPG	TOTAL
May '50	13,046	7,331	19,377	12,907	6,940	19,747
May '49	11,262	5,626	16,888	11,206	5,576	16,874
Change	+784	+1,605	+2,389	+1,599	+1,364	+2,873
% Change	6.9	28.5	14.2	13.4	24.5	17.0
	Total Production (1000 gal.)			Total Demand (1000 gal.)		
May '50	1,798,859	1,303,381	3,092,113	1,784,353	1,183,506	2,967,859
May '49	1,654,873	975,528	2,630,401	1,641,310	973,549	2,614,859
Change	+143,977	+327,735	+371,712	+143,023	+209,967	+353,010
% Change	8.7	33.2	14.1	8.7	21.5	13.5

Stocks, End of Month (1000 gal.)

	By Type of Product: Natural Gasoline	LPG	Other Products†	By Location: Refineries	Gasoline Plants	TOTAL
May '50	213,325	73,639	56,009	119,784	223,089	342,864
April '50	207,717	66,397	59,805	87,738	246,181	333,919
May '49	209,558	58,925	52,984	65,176	226,391	311,567

* Demand, including exports but not transfers, is supplied from receipts from outside sources as well as current production and stock changes. Outside receipts totaled 769,000 gals. in May.
** Does not include LPG produced at refineries which in May totaled 95,424,000 gals.
† Includes naphtha, kerosine, specialty and other products.

ADVERTISERS' INDEX

FOR INFORMATION ON ANY PRODUCT OR SERVICE ADVERTISED IN THIS ISSUE SEE INSTRUCTIONS BELOW

Each advertiser listed in this index has been assigned a code letter for use by the reader in securing additional information about advertised products or services which interest him. This code letter appears in parentheses to the left of the advertiser's name.

●

Circle the code letter on the "Advertised Product Inquiry" card (on the page opposite) which corresponds to that assigned the advertiser about whose product you want further information.

Fill in your name, title, company and mailing address and mail the card. . .no postage is required.

The Petroleum Processing Reader Service Department will give your inquiries prompt and efficient handling.

(A) ALLIED CHEMICAL & DYE CORP., GENERAL CHEMICAL DIV. ..... Inside Back Cover

(BQ) ALLIED CHEMICAL & DIE CORP. SOLVAY SALES DIV. 870

(B) ALUMINUM CO. OF AMERICA .. 860

(C) ALUMINUM CO. OF AMERICA .. 877

(D) AMERICAN CYANAMID CO. 784

(E) ARCO CO., THE 809

(F) ATLAS MINERAL PRODUCTS CO. 890

(G) ATTAPULGUS CLAY CO. 812

(H) BABCOCK & WILCOX TUBE CO., THE 796

(I) BABCOCK & WILCOX TUBE CO., THE 808

(J) BADGER & SONS CO., E. B. ..820, 821

(K) BETHLEHEM STEEL CO. 799

(L) BETZ, W. H. & L. D. 875

(M) BOWSER, INC. 854

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(S) CRANE PACKING CO. 858

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(U) DU PONT DE NEMOURS & CO., INC., E. I. ..... FACING 810 & 811

(V) DU PONT DE NEMOURS & CO., INC., E. I. 891

(W) ELECTRIC AUTO-LITE CO., THE 872

(X) ETHYL CORP. 779

(Y) FILTROL CORP. 819

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(AA) FOSTER WHEELER CORP. ..... Facing 886 & 887

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(AC) GENERAL AMERICAN TRANSPORTATION CORP. 780

(AD) GENERAL AMERICAN TRANSPORTATION CORP. 892

(A) GENERAL CHEMICAL DIVISION ALLIED CHEMICAL & DYE CORP. ..... Inside Back Cover

(AF) GIRDLER CORP., THE 883

(AG) GLOBE STEEL TUBES CO. 797

(AH) GRAVER TANK & MFG. CO., INC. 811

(AI) GREENE, TWEED & CO. 869

(AJ) GRINNELL CO., INC. 855

(AK) GRISCOM-RUSSELL CO. 802, 803

(AL) HARTZELL PROPELLAR FAN CO. 800

(AM) HOPKINS' VOLCANIC SPECIALTIES 862

(AN) HOUGHTON LABORATORIES, INC. 886

(AO) HUDSON ENGINEERING CORP. ..... Inside Front Cover

(AP) JERGUSON GAGE & VALVE CO. 856

(AQ) KELLOGG CO., THE M. W. .... Facing 850 & 851

(AR) MATHIESON CHEMICAL CORP. . 875

(AS) METAL TEXTILE CORP. 788

(AT) MONSANTO CHEMICAL CO. 791

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(AV) NATABCO CO. 894

(AW) NATIONAL AIROIL BURNER CO. 897

(AX) NATIONAL FOAM SYSTEM, INC. 808

(AY) NORDSTROM VALVE DIV. ..... Facing 794 & 795

(AZ) OHIO STEEL FOUNDRY CO 794

(BA) OAKITE PRODUCTS, INC. 893

(BB) OIL WELL SUPPLY CO. 859

(BC) PENBERTHY INJECTOR CO 815

(BD) PETRO-CHEM DEVELOPMENT CO., INC. 805

(BE) PETROLEUM RECTIFYING CO. .. 806

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(BX) WOLVERINE TUBE DIV., CALUMET HECLA CONSOLIDATED 888

(BY) WORTHINGTON PUMP & MACHINERY CORP. 816

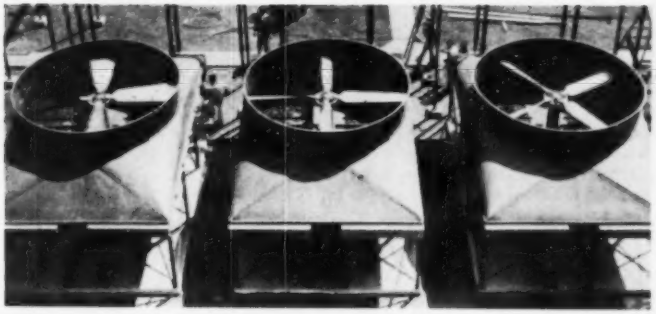
(BZ) WYATT METAL & BOILER WORKS ..... Outside Back Cover

(CA) YARNALL-WARING CO. 866

What's New!

EQUIPMENT . . . MATERIALS . . . PROCESSES . . . LITERATURE

Reviewed by **WILLIAM C. UHL, Equipment Editor**



THREE COOLING TOWER FANS installed recently in a Maysville, Okla., refinery

Cooling Tower Fans Use Modification Of Standard Aircraft Propeller Design

The "Aeromaster" industrial axial fan for air-cooled heat transfer equipment utilizes aerodynamic design principles and is said to effect up to 10% savings in horsepower consumption by providing greater cooling capacity with an existing unit or an equal capacity with a smaller horsepower requirement. It is being manufactured by aircraft production techniques in a shop which makes automatic pitch propellers for small planes. Designed for continuous operation, the fan is available in sizes from 6 to 20 ft. in diameter. Each of the 14-ft. fans shown in the photo is capable of delivering 275,000 cfm. The largest size, 20 ft., delivers 500,000 cfm. Blade profile is modified from standard aircraft shape to move large volumes at minimum horsepower rather than develop high thrust. Blade core is laminated birch, bonded with "Penacolite" resins. The wood is splayed at alternate angles to increase torsional strength. An inert, "Aeroloid" plastic covering increases resistance to weather, abrasion, and mild acids and alkalines. Blades may be removed or adjusted as to pitch angle without removing hub installation. For ease and accuracy during installation, blades and hubs are index marked for proper angles. Koppers Co.

Circle No. **1** *on Reply Card*

For More Information

Use one of the attached reply cards to request additional details or literature on any items reviewed in "What's New!" Just circle the numbers corresponding to the numbers at the end of each item in which you are interested. Then fill in the rest of the card and drop it in the mail. No postage required.

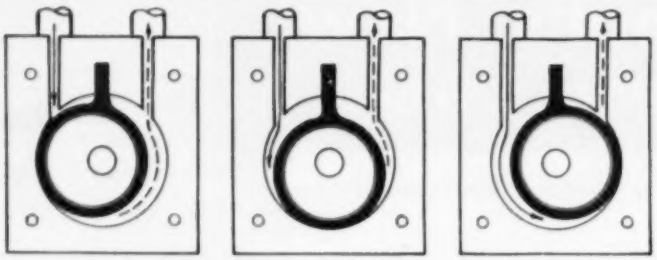
Rapid Field Inspection of Metal Parts, Welds, etc., Obtained by Dye Process

A new metal inspection process known as "Dy-Chek", developed originally by a subsidiary of Northrop Aircraft for rapid inspection of gas turbine engines and parts, is expected to find uses in many fields. Not only applicable to mass production work, it can also be used by a single field inspector checking parts of vessels, piping, etc. in the plant without dismantling. In use, a patented nontoxic, non-corrosive red dye penetrant is first applied to the surface of a suspected part and allowed to stand five minutes. It is then wiped off with a special surface cleaner and dye remover, and a white "developer" solution is applied. Any surface openings can then be detected by the presence of fine red lines or dots created as the dye—possessing extremely high capillary action—is drawn from the fissure by the developer. The process has been satisfactorily tested in weld shops, foundries, and forging plants for 18 months, the manufacturer states. The Dy-Chek Co., Division Northrop Aircraft, Inc.

Circle No. **2** *on Reply Card*

"Squee-Gee" Lined Laboratory Pump Combats Corrosion and Contamination

The "Flex-i-Liner," packless, positive displacement, laboratory pump has been developed for handling contaminating or corrosive liquids and gases. In an application at Esso Research Laboratories it is being used to transfer LPG at 100 to 200 psig. The construction is such that the fluid flows on the outside of a flexible lining material and inside the body block. The liner can be synthetic



FLEXIBLE LINER on pump rotor reduces corrosion problem

or pure gum rubber, depending on requirements. The body block is manufactured of corrosion and abrasion resistant Bakelite. An eccentric rotor activates the lining material providing a "squeegee" action. The unit measures 3⅝ x 4½ x 2½ in., and is available in five models with capacities of 300, 180, 120, 60, and 20 gph. Pumps may be obtained dismounted or mounted and direct-connected to a ¼-hp. AC motor operating at 1750 rpm. Vanton Pump Corp.

Circle No. **3** *on Reply Card*

Continuous Blow-Off Valve with 15 Calibrated Orifices Saves Boiler Heat

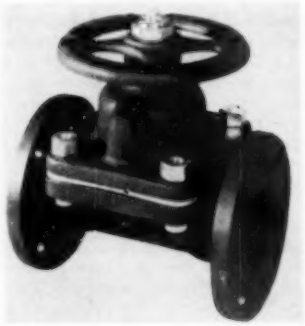
Elimination of intermittent manual blow-off with a new continuous boiler blow-off valve is said to save up to 25% of heat otherwise wasted. The unit will remove highly concentrated impurities from 4 to 6 in. below the water surface at the same rate they are introduced. It eliminates foaming and carry-over by maintaining predetermined concentration. An indexing control disc with 15 calibrated orifices is quickly adjusted to permit any required flow. Made of hardened stainless steel, the orifice disc is regulated to provide constant blow-off measured in lbs./hr. of water. Each orifice is indexed and numbered to correspond to a flow chart provided with the unit. A sedimentation separation chamber located ahead of the valve prevents scale or other impurities from plugging the orifice. A velocity reducing chamber absorbs the erosive high velocity jet of contaminated boiler water. The valve unit is 42 x 11 x 4 in. in overall dimensions and weighs 40 lbs. It is hydrostatically tested at 1000 psi. before shipping. The Uniblow Valve Co.

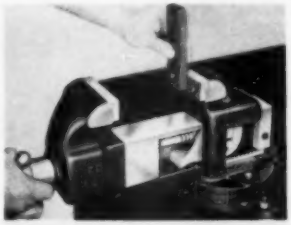
Circle No. **4** *on Reply Card*

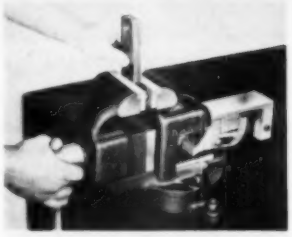
Polyethylene Diaphragm Assures User Of Safety in Sulfuric Acid Valve

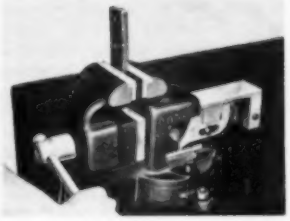
A new valve developed to handle concentrated sulfuric acid and other highly corrosive fluids has a diaphragm which reduces maintenance problems. Molded of "Bakelite" polyethylene plastic formulated specifically for this purpose, the diaphragm handles all concentrations of sulfuric acid, up to and including oleum, at a maximum of 10% excess SO_3, at temperatures to 125° F. The valve has "O" ring reals in the bonnet assembly to prevent acid from spraying out if mechanical damage should occur to the diaphragm. A stem assembly prevents the handwheel being turned beyond the point necessary to close the valve tightly and thus injuring the diaphragm. Available in ½, 1, 1½, 2, and 3-in. sizes, flanged or screwed end, the valves are made in such body materials as cast iron, cast steel, lead-lined, and glass-lined. Operation may be by lever, diaphragm motor, cylinder, chain wheel, or other methods. Hills-McCanna Co.

Circle No. **5** *on Reply Card*









Slide Action Bench Vise Speeds Up Small Work in Maintenance Shops

A patented fast slide action in the new "Slide-Set" Vise permits opening or closing the bench tool to any position in one second through a push-pull, pawl-and-ratchet mechanism which eliminates spinning the handle. A one and one-half turn of the handle counter-clockwise allows the jaw to slide in "neutral" to any position. Once the work is engaged, the vise operates in the conventional manner. The vise is provided with either a swivel or stationary base and is built in one size, 4 in. Total weight is 58 lbs. Dodge Mfg. Corp.

Circle No. **6** *on Reply Card*

WARREN'S *Stabilized*

NATURAL GASOLINE

OR STA-VOL-ENE

for

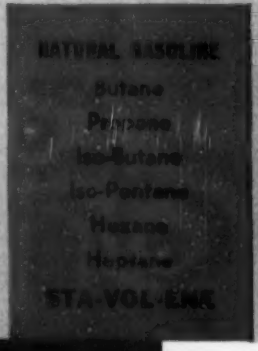
EXTRA ENERGY

OR

ANY EMERGENCY

The need for quicker action, instant speed, greater energy and dependability is no longer confined to the police and fire departments or ambulances. Today's traffic presents this problem every hour on any highway, street intersection or airport.

The demands for more power, action and energy to match the fast-moving tempo of highway traffic and modern industry are being met with Warren's Stabilized Natural Gasoline. Blend with Warren's to insure a stabilized product with higher octane and lower cost. It has fine lead susceptibility.



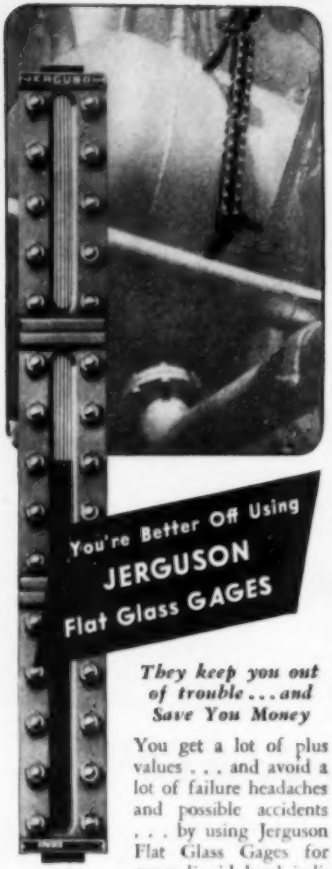
WARREN PETROLEUM CORPORATION

Producers, Manufacturers, Exporters and Marketers

Export Terminals: Corpus Christi, Port Arthur, Baytown, Texas City, and Norsworthy, Houston, Texas.

TULSA 2, OKLAHOMA CABLE ADDRESSES: Stavolene, Warren

Crude Oil, Natural Gasoline and Liquefied Petroleum Products



Jerguson Reflex Gage

They keep you out of trouble . . . and Save You Money

You get a lot of plus values . . . and avoid a lot of failure headaches and possible accidents . . . by using Jerguson Flat Glass Gages for every liquid level indicating use.

You get the kind of gages and valves you want to do YOUR JOB. Jerguson offers you the most complete line available. Jerguson offers you an engineering organization specializing in building special gages to meet problems.

Jerguson Flat Glass Gages save money and labor. They are easy to install. They stand up . . . you don't have to keep servicing them or replacing the glass. They are available in a wide range of sizes, pressures, designs and materials; also with polished end stems to replace present tubular gages.

Write us about your problems or requirements.

JERGUSON

Gages and Valves for the Observation of Liquids and Levels

JERGUSON GAGE & VALVE COMPANY
100 Fellsway, Somerville 45, Mass.
Representatives in Major Cities
Phone Listed Under JERGUSON

What's New!

Gasoline Fires Extinguished Faster With High Strength Foam Liquid

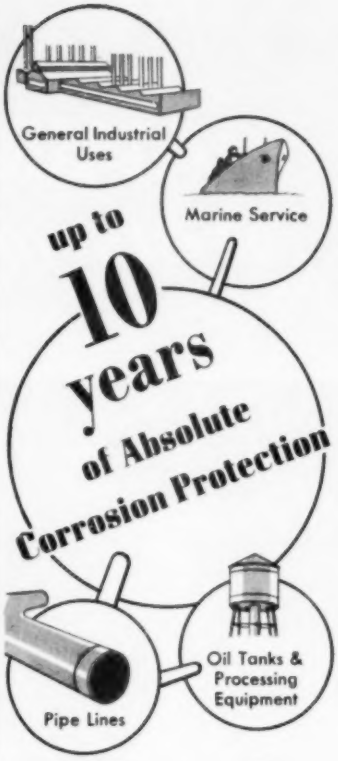
More rapid extinguishment of gasoline or other flammable liquid fires is claimed for the recently-announced Rockwood "Double-Strength" Foam liquid. The increased strength and flow properties mean that one gallon will produce twice the results of regular Rockwood foam, the manufacturer states. The material will flow freely at temperatures down to −20° F. and will stand up under tropical heat. It can be used with any of the newer or the standard foam systems and devices made by the manufacturer, Rockwood Sprinkler Co.

Circle No. **7** *on Reply Card*

Jet, Diesel Fuel Gum Determinations Handled by New Laboratory Unit

The gum content of jet and Diesel fuels can be determined by the air or steam jet method with a Bronze Block Gum Bath developed recently. Having a wide temperature range, the apparatus is said to be equally suitable for gum testing gasolines and low boiling volatiles (ASTM D-381). In use, the amount of gum is determined by evaporating a sample in an atmosphere of superheated steam, or under a stream of preheated air. The gum is the amount of non-volatile residue, expressed in milligrams per 100 ml. of sample. An accurate flow gage calibrated to indicate air flow in liters/sec. is provided. The five-unit bath has a temperature range from 300 to 600° F., automatically controlled to ± 5° F. The bronze block has been normalized to withstand the constant expansion and contraction. Three inches of glass wool insulates sides and bottom. Top insulation is electrobestos. Overall dimensions of the unit are 19 in. in diameter by 15½ in. in height. Precision Scientific Co.

Circle No. **8** *on Reply Card*



Hysol 4000 Coatings

Developed as a coating system for ship bottoms, Hysol now has been adapted for general industrial and oil field uses. Tough and abrasion-resistant, Hysol Coatings adhere firmly to any metal surface. *Write for specific information.*

- **Resist attack from salt water and practically all chemicals.**
- **8 colors.**
- **Easily applied using spray, brush, dip or roller methods.**

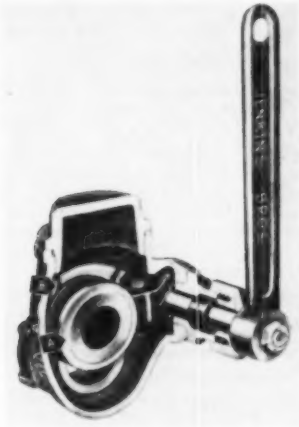
houghton laboratories, inc.
OLEAN, NEW YORK

What's New!

Service Offered for Flame-Spraying Polyethylene Inside Tanks, Vessels

A method of flame spraying polyethylene coatings on steel tanks, tank cars, and processing equipment has been perfected and is now available as a service. The process uses no solvents and applies coatings in thicknesses from $\frac{1}{32}$ to $\frac{1}{4}$ in. The tank to be coated is first sand blasted, then polyethylene in powder form is blown through especially designed flame spray equipment. Deposited on the tank in melted form, the plastic sets up to a tough, nonporous film with high resistance to most chemicals and corrosive materials. The manufacturer will coat existing equipment, supply coated tanks, or furnish equipment and personnel for coating field applications. Houghton Laboratories.

Circle No. **9** *on Reply Card*



Ball and Socket Type Discs Cut Wear Provide Tight Seals in Gate Valve

The "Swingtite" bronze, lever gate valve has ball and socket design double discs which adjust readily to seat surfaces. As shown in the illustration, guide rims (A) on these discs rotate freely on the guide tracks (B) cast in the body as the valve is opened or closed. This roller action provides a self-cleaning and polishing effect and distributes the wear. The malleable iron lever can be placed in four different positions with relation to the spindle. The valve is rated for 125 psi. steam, 300 psi. cold oil, water, and gas. It is made in $\frac{1}{2}$ to 2-in. sizes. Jenkins Bros.

Circle No. **10** *on Reply Card*

You're paying for this

*PRECISION-DOW DUAL RECORDOMATIC TITROMETER

until you use it-

If you run many titrations manually now, each costs you much more than with this fine new instrument.

A few weeks later, IT PAYS YOU

Automatically *controls* reagent-feeding and permanently *records* progress. Performs *four* functions at once!

With non-technical personnel, runs titrations in fraction of time required by conventional methods.

LABORATORIES REPORT: (Names on request)

1. "Paid for itself in first three months."
2. "Now run 60 titrations per day; formerly only 10."
3. "Frees our analyst for 6½ hours of other work per day."
4. "Cuts titration costs to scarcely one-third."

- Nothing like it on the market!
- Wide variety of applications!
- Surprisingly low price!
- Two complete titration set-ups!

Performing a highly complicated operation with reliable simplicity, this product is typical of those made possible by our exceptional facilities—a quarter-century of technological practice, close contact with laboratories and technical societies, complete and modern factory—all with a single responsibility.

ORDER FROM YOUR DEALER NOW . . . OR WRITE US FOR BULLETIN 1-649A

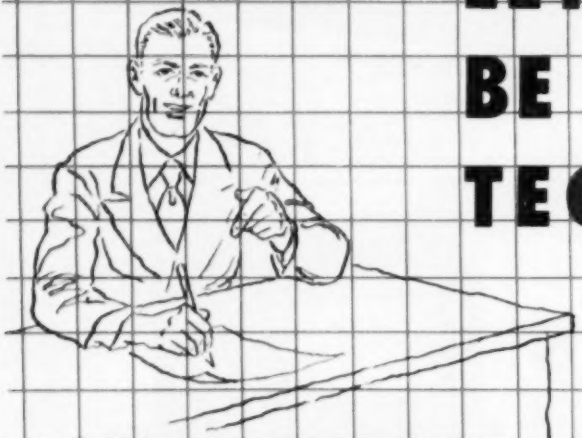
Precision Scientific Company

*The FINEST Research & Production Control Apparatus

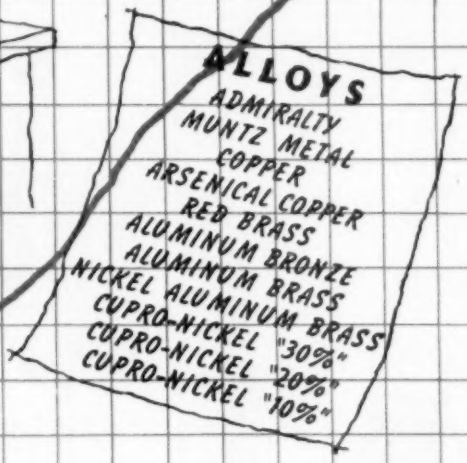
3737 W. Cortland Street, Chicago 47

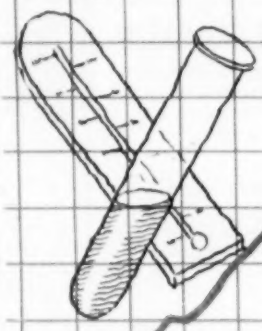
OFFICES IN NEW YORK • PHILADELPHIA • SAN FRANCISCO

LET'S BE TECHNICAL



Trained technical people are always at your command to consult on any development problem you may have. Constant research is going on all the time in order to be as helpful as we can and have ready for you the answers to any questions you may ask us.



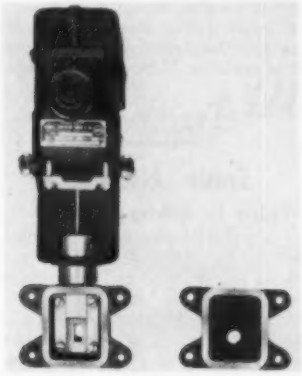


There is a proper alloy for each purpose. The choice depends upon the nature of the fluids or gases to be encountered. Our engineers can help you immeasurably in specifying the exact alloy you should employ under any given conditions.

We can help you with the diagnosis of your heat transfer problems—discuss with you such factors as temperatures, kinds of liquids and gases and their rates of flow, as they affect efficiencies in your operations.

WOLVERINE TUBE DIVISION
Calumet & Hecla Consolidated Copper Company
INCORPORATED
MANUFACTURERS OF SEAMLESS, NON-FERROUS TUBING
1425 CENTRAL AVE. • DETROIT 9, MICHIGAN

PLANTS IN DETROIT AND DECATUR, ALA.
Sales Offices in Principal Cities



Control Valve Provides Straight Line Proportional Flow Characteristics

An automatic control valve has been developed for handling fluids which require straight line proportional flow characteristics and minimum pressure drop and turbulence. Employing a slide valve design, the valve opening is rectangular so that as the gate is moved over it, flow is directly proportional to open area. Thus, the concentration of the opening for straight-through flow, without seats, bends, or divisions as in conventional valves, eliminates unnecessary restrictions. The opening can be designed to any other geometric figure as desired. Because the surfaces of the slide and of the body are lapped smooth, tight contact is made. There is no wire drawing, wear on valve seats, or mislocation of contact of closing parts. Body can be of cast iron, cast steel, stainless steel, or bronze, with internal working parts of stainless. The valve is built for pipe from ¼ to 2 in., and pressures to 300 psi. Various automatic or manual positioners may be used. W. S. Rockwell Co.

Circle No. **11** *on Reply Card*

Useful Dispersions of Sodium in Inert Media Made Possible by New Method

Concentrated dispersions of sodium in inert media, which can be handled easily in ordinary pipe at room temperatures, can now be made in the sodium user's own plant as a result of a new technique. Among uses for sodium dispersions are Claisen condensation reactions, desulfurizing and purification of hydrocarbons, polymerization catalysts, and many others. To aid the user, the manufacturer has prepared typical equipment layouts and has developed a special colloid mill set up for large quantity production of dispersions. Sodium is dispersed at up to 50%-wt. in such media as toluene, xylene, naphtha, kerosene, white oil, nujol, petroleum jelly, naphthalene, or paraffin. Particle sizes ranging from submicron to 20 microns, with an average of 2-3 microns, can be easily obtained. National Distillers Chemical Corp.

Circle No. **12** *on Reply Card*

Spreading Agent for Microcrystalline And Paraffin Waxes Now Available

"Paraspred," a spreading agent for paraffin and microcrystalline waxes, is now in full commercial production. In addition to its spreading properties, the material plasticizes paraffin wax improving its adhesiveness. Penetration into such porous materials as paper and textiles is improved also. Paraspred is a nontoxic, soft waxy solid, cream to yellow in color, with a melting range of 92 to 97° F. Glyco Products Co., Inc.

Circle No. **13** *on Reply Card*

Magnetic Particle Inspection Unit Is Made Portable for On-the-Job Uses

The new Model KH-05 Magnaflux Unit is a portable, general purpose tool designed for on-the-job, in-the-field, magnetic particle inspection of welds, castings, etc. for invisible fatigue cracks, shrink cracks, weld cracks, and the like. It can be carried in a car trunk, or wheeled to the job on its integrally mounted rubber tires. An accessory compartment provides storage for powder and materials and for the 30 ft. of magnetizing cable and the line cord to reach the nearest 110 volt outlet, on which power the unit operates. Cables are

WEDGEPLUG
ALL-PURPOSE
STEEL VALVES
LIFTS
TURNS
and
RE-SEATS
IN ONE
OPERATION
DRY
PLUG
PRICED to compete with conventional plug-type valves. Interchangeable with American Standard Steel Wedge Gate Valves. Wrench-Operated; Direct Handwheel-Operated; Worm Gear-Operated; Sizes from 1" to 16". Write for our Catalog No. 600 and Price List. On request, we will be glad to quote on larger sizes above 16".
Wedgeplug Valve Co., Inc.
Department "P"
New Orleans 15, U.S.A.

[*To obtain more data on advertised products see page* 882]

equipped with "Eitherend" connectors. Outlets on the unit allow connection for AC or DC magnetizing current, whichever is desired. A hinged cover protects the instrument panel from weather or other abuse. The complete price of $485 includes a day of instruction in magnetic particle inspection. The Magnaflux Corp.

Circle No. **14** *on Reply Card*

Sensitive Expansion Tube Actuates Low Level Boiler Water Alarm

The Campbell "Micro-Thermal Low-Level Boiler Alarm" is a highly sensitive device for signalling when low water level is reached. It consists of a ⅝-in. expansion tube with its inner end connected to the lower end of the water column on the boiler. Its outer end is connected to the upper part of the water column by a ¼-in. copper tube. The water therefore rises and lowers above the expansion tube. When the water level reaches its low level the increased heat in the tube expands the walls and actuates a micro-switch of the double-throw type which can be connected to a doorbell, buzzer, bell, or howler on one throw. The other throw may be connected to a solenoid valve in the fuel line if desired. A screw adjustment on the expansion tube permits setting at any level desired. The switch will throw on and off on a temperature change of 5° F. The device can be attached to any column regardless of boiler size or length of column by use of the flexible tube. The alarm switch can be connected to a single 6-volt dry cell. J. A. Campbell Co.

Circle No. **15** *on Reply Card*

Tungsten Carbide Laboratory Pencil Is Inexpensive Substitute for Diamond

A tungsten carbide pencil for permanently marking laboratory glassware has been made available. Slightly below the diamond on the hardness scale, tungsten carbide is cheaper than diamond and comes to a definite point rather than an edge as is found on a diamond tip. The tungsten carbide point is permanently mounted in a knurled steel pencil shaft and protected by a cap so it can be carried safely in the pocket. Its uses include: identification of sealed vials of standard colorimetric samples; scoring sheets of glass accurately for breaking, and the like. It is priced at $1.25. Fisher Scientific Co.

Circle No. **16** *on Reply Card*

Trade Literature

Additive for Bearing Greases

"Ortholeum" 300 Grease Stabilizer, Bulletin No. GS-50, a four-page technical report covering composition, properties, uses, handling instructions, packaging information on an additive designed to provide antioxidant and metal deactivating qualities in bearing greases. Du Pont Petroleum Chemicals Division.

Circle No. **17** *on Reply Card*

Protective Coating for Tanks

Natasco Interior Tank Corrosion Treatment, a four-page folder describing a special contract service for coating storage tank interiors for protection against corrosive crude oils. The Natasco Co.

Circle No. **18** *on Reply Card*

Atlas research announces

ALKOR 5E

the superior acid and alkali proof cement for joining brick and tile

This is the news you have waited for, ALKOR 5-E, the nearest thing to a universal corrosion-resistant cement. Check these properties: Inert to all solvents and alkalies; Resistant to all non-oxidizing acids; No appreciable shrinkage on setting; No obnoxious odors; Excellent workability; Easily tooled; Adhesion to wire cut brick greater than 500 psi; Tensile strength 1500 psi; Compressive strength 15,000 psi; Heat accelerates setting only, no fumes or smoke; Sets in less than 24 hrs. at 70° F. For complete information write us at 19 Walnut Street, Mertztown, Penna.

THE ATLAS MINERAL PRODUCTS COMPANY
MERTZTOWN, PENNA. HOUSTON, TEXAS

Du Pont Announces

"ORTHOLEUM" 300 GREASE STABILIZER

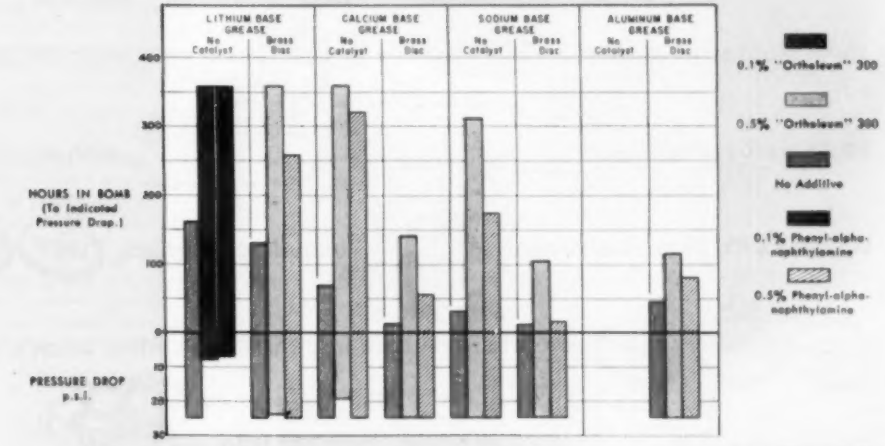
To help meet the demand for greases of higher stability to stand up under the higher temperatures and loads of many present-day grease applications, Du Pont has developed "Ortholeum" 300 Grease Stabilizer. This new additive combines both antioxidant and metal deactivating properties. The combination imparts oxidation stability to the grease superior to that attainable with antioxidants alone and in addition does not cause discoloration of the finished product.

The effectiveness of "Ortholeum" 300 has been evaluated in many types of greases and laboratory tests show marked superiority over compounds such as Phenyl-alpha-naphthylamine. This is indicated in the chart below which gives results of Norma-Hoffman Oxidation Tests on several greases.

"Ortholeum" 300 is easily added to the grease during manufacture and cost of using it is very low. For the normal concentrations, treating cost runs only around .4¢/lb.

SEND FOR SAMPLES . . . to evaluate in your own greases. Write the nearest District Office or ask your Petroleum Chemicals representative for samples. Also, for more complete information ask for Technical Bulletin GS-50.

NORMA-HOFFMANN OXIDATION TEST



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Easy Lesson in CONSERVATION ECONOMICS

If you have several cone roof tanks

that can be interconnected,

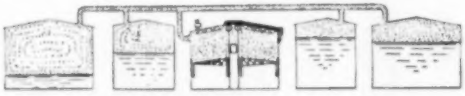
you can convert breathing losses

and filling losses

into profits quickly. Field studies at a typical gasoline plant

show $aving$ of more than 5,000 gallons

a week when six cone roof tanks were hooked up



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WIGGINS VAPOR SEAL GENERAL AMERICAN

Open Steel Grating

Klemp Open Steel Grating and Stair Treads, a 24-page technical manual explaining and illustrating various types: diamond riveted open steel grating, welded electric-forged open steel flooring and stair treads, bridge decking, and some products in aluminum. Klemp Co.

Circle No. **19** *on Reply Card*

Centrifugal Process Pumps

Worthington Type HM Centrifugal Process Pumps, Bulletin W-341-B14: four pages on a vertically-split, single stage pump capable of pressures up to 450 psi., temperatures to 500° F., for corrosive or non-corrosive liquids, in cast iron, bronze, stainless steel, carbon steel, and Worthite, with optional mechanical seals. Worthington Pump and Machinery Corp.

Circle No. **20** *on Reply Card*

Air Trap Information

Armstrong Air Traps, Bulletin No. 202; covers the selection and installation of this type equipment for automatic drainage of water from compressed air intercoolers, aftercoolers, receivers, separators, and drip points; includes physical data and prices. Armstrong Machine Works.

Circle No. **21** *on Reply Card*

Flange and Coupling Selector

The Nooter Flange and Coupling Selector is a pocket-size, slide rule tool presenting all pertinent data for 150 and 300 psi., ASA, as well as for standard, extra heavy, 3000 and 6000 psi. coupling, with a table showing wall thicknesses of standard, extra heavy, and double extra heavy pipe in all Schedules from 10 through 160. Nooter Corp.

Circle No. **22** *on Reply Card*

Water Engineering Services

Let's Consider Your Whole Water Problem — Procurement, Treatment, Usage, Disposal; four pages covering the engineering services in this field being offered by Hall Laboratories, Inc.

Circle No. **23** *on Reply Card*

Ion Exchange Water Treatment

Amberlite Monobed Deionization, 12-page booklet presenting theory and principles and describing the equipment used in a synthetic resin-using process for such applications as water conditioning, industrial waste treatment, removal of acidic materials from crude or refined oils, removal of metallic catalyst poisons from cracking stocks, stabilization of lubricating greases, and recovery of petroleum by-products. Resinous Products Div., Rohm & Haas Co.

Circle No. **24** *on Reply Card*

Industrial Chemicals

Products of Columbia, a 26-page, pocket-size booklet outlining a range of chemicals including soda ash, caustic soda, liquid chlorine, sodium bicarbonate, calcium chloride, modified sodas, caustic ash, mono-chlorobenzene, muriatic acid, and many others; with typical uses and types of shipping containers. Columbia Chemical Div., Pittsburgh Plate Glass Co.

Circle No. **25** *on Reply Card*

Small Cast Steel Valves

Another Powell Achievement, a six-page folder describing, with dimensioned drawings, a new line of small size—¼ to 2 in.— high pressure, cast steel, globe, angle, and "Y" valves, designed for such services as high pressure steam, boiler feedwater, by-

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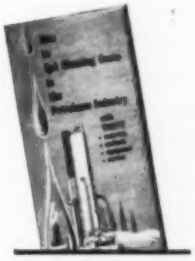

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OAKITE

PETROLEUM SERVICE DIVISION

[*To obtain more data on advertised products see page* 882]

pass, instrument, and throttling, at 1500 and 2500 psi., with socket weld ends. The Wm. Powell Co.

Circle No. **26** *on Reply Card*

Strainers and Separators

ADSCO Strainers and Separators, Bulletin R-46-50A; a revised 16-page catalog on Y and T-type strainers, suction strainers, multi-flow separators and receiver-separators, containing dimensions, weights, and list prices, and including technical data on proper selection, flange dimensions, and service pressure ratings. American District Steam Co.

Circle No. **27** *on Reply Card*

Industrial Thermometer Catalog

Princo Industrial Thermometers, Bulletin E; 16 pages of catalog information, application data, on line of mercury-in-glass thermometers with fixed thread, fixed flange, union, and special connections. Precision Thermometer and Instrument Co.

Circle No. **28** *on Reply Card*

Corrosion-Resistant Paints

Tygon Corrosion-Resistant Paint, Bulletin 712; 12 page booklet giving data and corrosion resistance tables on this line of protective coatings. U. S. Stoneware Co.

Circle No. **29** *on Reply Card*

Recording Temperature Instruments

Bristol Series 500 Recording Thermometers for Temperatures Between −125 and 1000° F., Bulletin TS40; 44 pages of information on liquid-filled, vapor pressure, and gas-filled types in models for recording, indicating, controlling, and telemetering. The Bristol Co.

Circle No. **30** *on Reply Card*

Corrosion-resistant Materials

Chemical Construction Materials, General Bulletin MCC No. 1; eight pages on corrosion-proof linings and cements, acid-proof brick and tile, brick sheathings, coatings, and floors, including estimating data. Atlas Mineral Products Co.

Circle No. **31** *on Reply Card*

Water Softening, Clarification

Cochrane-Liquon Sludge Contact Reactors, Publication 5001; 16 pages of description and typical applications of a new water treating process based on the principle that previously formed precipitates added in the form of a sludge or slurry will accelerate chemical reactions. Cochrane Corp.

Circle No. **32** *on Reply Card*

Multiple Quantity Liquid Packager

Bowser Model J (100 Quantity) Packaging Dial; folder describes and illustrates a packaging meter which automatically dispenses any pre-set quantity from 1 to 100 gals. for filling drums or other containers. Bowser, Inc.

Circle No. **33** *on Reply Card*

MAN FROM MARS?

This queer-appearing fellow might have stepped out of a movie of another world; but actually he is only one of a trained NATASCO Crew. Protected by specially designed clothes, he sandblasts such surfaces of tanks as require this treatment before NATASCO corrosion prevention products are applied. He is just one of a crew of skilled men, with equipment built for each specific task, who will make money for you by protecting your tanks against corrosion.

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For Your Convenience

Business reply cards are included in each issue of PETROLEUM PROCESSING to assist you in obtaining more information on any items reviewed in "What's New!" You'll find them facing the first page of this section. Just circle the numbers corresponding to the numbers at the end of each item in which you are interested. Then fill in the bottom of the card and drop it in the mail. No postage required.

Personals

Dr. James B. Garner, of the Mellon Institute (University of Pittsburgh), has been awarded the doctor of science degree by Wabash College, his alma mater. Dr. Garner was graduated from Wabash in 1893 and two years later received his M.S. degree. In 1897 he was graduated magna cum laude from the University of Chicago with a Ph.D. degree. From 1901-14 he was professor of chemistry at Wabash and since 1914 has been a fellow and professor in the Mellon Institute. His chemical work in the steel, coal and petroleum industries have brought him wide recognition.

Dr. Garner

* * *

E. H. Atwood, former chief engineer, has retired after 38 years of Socony-Vacuum service. **J. L. Lawrence,** who joined the company at Paulsboro as assistant chief engineer in 1946, has been appointed to succeed Mr. Atwood.

Mr. Atwood started with Vacuum Oil Co.'s refinery in Olean, N. Y., after graduation from Cornell University and was the first engineer employed by this predecessor of Socony-Vacuum. He was in Europe for Socony-Vacuum between 1929 and 1940, and directed construction of the Port Jerome (now Notre Dame de Gravenchon) refinery in France.

* * *

H. O. Evinger, former superintendent of Sun Oil Co.'s Jameson natural gasoline plant in Coke County, Texas, has been named superintendent of the company's Sun Field natural gasoline plant, Starr County, Texas. **J. Shimer** has been appointed to succeed him at the Jameson plant. **R. L. Cochran,** former superintendent of the Sun Field plant, has been transferred to Brookhaven, Miss., for a special assignment.

* * *

J. R. Griffin, former chief engineer in Sharples Corp.'s research laboratory, has joined the technical staff of du Pont's petroleum chemicals division as aviation consultant and will specialize principally in fuel and lubrication problems in aviation.

Mr. Griffin was graduated from the University of California with a master's degree in mechanical engineering. Following a brief period as instructor in the department of mechanical engineering of the University of Texas, he joined the research laboratory staff of Shell Development Co., Emeryville, Calif. Later he went to Trans World Airline to handle maintenance and operations engineering problems.

* * *

G. G. Oberfell, vice-president of research and development for Phillips Petroleum Co., retired August 1. His position has been filled by **R. W. Thomas,** former manager of the research and development department.

Mr. Thomas

Mr. Oberfell had been with Phillips nearly 26 years. He established the company's research department, and is himself a nationally recognized authority on petroleum research, especially in the fields of natural gasoline, natural gas and lighter hydrocarbons.

Mr. Thomas started with Phillips in the engineering department in 1926, and for several years thereafter pioneered the development of markets for liquefied petroleum gases, with offices at Detroit. He took over his present duties at the headquarters office about ten years ago.

* * *

Dr. C. O. Tongberg has been appointed associate director of Standard Oil Development Co.'s research division, succeeding **S. C. Fulton** who has become associate director of the chemical division. Two other promotions include **J. G. McNab** and **C. L. Fleming** as assistant directors under Dr. Tongberg.

Dr. Tongberg, who was born in Lynn, Mass., is a graduate of Harvard and Penn State Universities. He joined Standard in 1937.

* * *

Walter R. C. Miller, coordinator of the world-wide extensive mechanical shop modernization program of Standard Oil Co. (N. J.), retired July 1st after more than 30 years service.

Mr. Miller started his company service as a draftsman in 1919 with Midwest Refining Co., Wyo. He was transferred to Lago Oil and Transport Co. in 1928 and was sent to Aruba, N.W.I., with the first refinery construction group as head of the pipefitters department and was there when the refinery first started operation in 1929. In 1936 he was appointed mechanical superintendent of the Aruba refinery and saw it grow to become the world's largest refinery before he was transferred to Standard Oil Development Co. in 1947.

* * *

H. P. Caldwell, a member of Socony-Vacuum Oil Co.'s laboratories at Paulsboro, N. J., since 1936, has been made supervisor of the refining section of their research and development laboratories. Mr. Caldwell was employed by General Petroleum Corp., a Socony-Vacuum affiliate, in 1934, after receiving his B.S. degree in chemical engineering at Purdue University.

* * *

Dr. E. P. Luongo, medical director of General Petroleum Corp., Los Angeles, has been elected to the presidency of the Western Assn. of Industrial Physicians and Surgeons. A vice-president of the Association last year, Dr. Luongo has also previously served as director of the organization. Dr. Luongo has been with General Petroleum since 1947.

* * *

L. D. Jurs, vice president of Tide Water Associated, has retired after 39 years with the company.

Mr. Jurs started with Tide Water in 1911 as a draftsman in the engineering department. The following year he was appointed chief engineer. He was elected a vice president of Associated Oil Co. in 1927 and in 1936 was made a vice president and member of the board of Tide Water Associated.

Mr. Jurs

Since 1940, Mr. Jurs has been the vice chairman of the company's western division operating committee.

He will remain as a member of Tide Water's board of directors, and will continue to reside in Oakland, Calif.

* * *

E. L. Sinclair has been appointed assistant to R. R. Jackson, manager of Socony-Vacuum Oil Co.'s refinery at Paulsboro, N. J. Mr. Sinclair, a graduate of the University of Michigan, joined the company as a draftsman in 1938 and was transferred from the refinery engineering department in New York to Paulsboro in 1949.

R. M. Chesney, former assistant operating superintendent, has been promoted to operating superintendent and **T. C. Lockhart** has been appointed to succeed him. Mr. Chesney, a graduate of the University of Dela-

ware, started with the company in 1932 as a chemist. Mr. Lockhart, a graduate of Drexel Institute of Technology, also started as a chemist in 1936.

* * *

Dr. Harold Vagtborg, San Antonio, Texas, president of Southwest Research Institute, received an honorary Doctor of Laws degree from Missouri Valley College, Marshall, Mo., June 4. Already the holder of a D. Sc. degree, Dr. Vagtborg received the LL.D. degree in recognition of his "record of service in the field of vital research" and other achievements. He formerly was president of Armour Research Foundation, Chicago, and Midwest Research Institute, Kansas City.

* * *

R. S. Tulin, manager of Shell Oil Co.'s natural gas and gasoline department, was elected president of the California Natural Gasoline Assn. last month. He succeeds **J. B. Taylor,** manager of Signal Oil & Gas Co.'s gas department.

* * *

G. C. McLaren, general superintendent of the southern district natural gasoline department of Standard Oil Co. (Calif.), was elected vice-president, and **E. R. Millett, Jr.,** was reappointed secretary-treasurer.

A. L. Pomeroy has been appointed director of development for Thompson Products, Inc., Cleveland, O. Prior to his joining Thompson as staff engineer in 1947,, he was manager of engineering operations for Ranger Aircraft Engines. Previously he was associated with the research and development department of Atlantic Refining Co. He is a member of the Society of Automotive Engineers and is chairman of the aviation fuels division of the Coordinating Research Council.

* * *

F. M. Collins, recent graduate of Michigan State College, and **Frank W. McDowell,** recent graduate of Pennsylvania Military College, have joined Atlantic Refining Co.'s research and development department in Philadelphia.

* * *

John C. Dean, former manager of the chemical products division of Socony-Vacuum Oil Co.'s lubricating department, has been made sales manager of the company's New England division located in Boston.

* * *

N. J. Gothard, formerly assistant chief chemist for Sinclair Refining Co.'s East Chicago, Ind., refinery, has been appointed chief chemist. He will make his headquarters at Harvey, Ill., the site of Sinclair's new research laboratories.

Mr. Gothard was graduated from the University of Wisconsin in 1914 with a degree in chemistry. Prior

MEETINGS . . . for the Oil Man

AUGUST

14-16. Third Western Packaging Exposition, Civic Auditorium, San Francisco.

14-16. Society of Automotive Engineers, West Coast Meeting, Biltmore Hotel, Los Angeles.

SEPTEMBER

3-8. American Chemical Society, 118th National Meeting, Chicago.

5-9. American Chemical Society, 6th National Chemical Exposition, Chicago Coliseum, Chicago.

10-13. American Institute of Chemical Engineers, Regional Meeting, Radisson Hotel, Minneapolis.

13-15. National Petroleum Assn., Hotel Traymore, Atlantic City.

18-20. National Butane-Propane Assn., Congress Hotel, Chicago.

18-22. Instrument Society of America, Fifth National Instrument Conference and Exhibit, Memorial Auditorium, Buffalo.

18-22. American Society of Mechanical Engineers Instruments & Regulators Division, joint meeting with Instrument Society of America, Municipal Auditorium, Buffalo.

19-21. American Society of Mechanical Engineers, Fall Meeting, Hotel Sheraton, Worcester, Mass.

25-27. American Society of Mechanical Engineers, Petroleum Division Conference, Roosevelt Hotel, New Orleans.

26-27. American Institute of Mining and Metallurgical Engineers, 1949 Mid-Year Meeting, Neil House and Deshler-Wallick Hotels, Columbus, Ohio.

26-29. Industrial Packaging and Materials Handling Exposition, Philadelphia.

27-30. Society of Automotive Engineers, Aeronautic and Aircraft Engineering Display, Biltmore Hotel, Los Angeles.

OCTOBER

2-6. American Gas Assn., Annual Convention, Atlantic City.

15-21. National Oil Industry Information Committee, Oil Progress Week, Roosevelt Hotel, New Orleans.

16-20. National Safety Congress, National Safety Council Exposition, Chicago.

23-27. American Institute of Electrical Engineers, Fall General Meeting, Skirvin Hotel, Oklahoma City.

23-27. American Society for Metals, Annual Meeting, Chicago.

23-27. American Welding Society, Annual Meeting, Chicago.

24. Assn. of Consulting Chemists and Chemical Engineers, Inc., Annual Meeting, Shelburne Hotel, Skyline Room, New York.

27. National Gasoline Assn. of America, Southern Regional Meeting, Blackstone Hotel, Tyler, Texas.

30-Nov. 1. National Lubricating Grease Institute, Annual Meeting, Edgewater Beach Hotel, Chicago.

NOVEMBER

2-3. Society of Automotive Engineers, Diesel Engine Meeting, Knickerbocker Hotel, Chicago.

9-10. Society of Automotive Engineers, Fuels and Lubricants Meeting, Mayo Hotel, Tulsa.

13-16. American Petroleum Institute, 30th Annual Meeting, Biltmore and Ambassador Hotels, Los Angeles.

13-17. National Electrical Manufacturers Assn., Chalfonte-Haddon Hall, Atlantic City.

26-Dec. 1. American Society of Mechanical Engineers, Annual Meeting, Hotel Statler, New York.

27-Dec. 2. 19th Exposition of Power and Mechanical Engineering, Grand Central Palace, New York.

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to joining Sinclair in 1919, he worked with Armour & Co., Chicago, and also with the City of Chicago's sanitary district.

* * *

William E. Morris, former research engineer for Standard Oil Development Co., has joined the du Pont petroleum laboratories at Deepwater, N. J., to study the performance of leaded gasolines in automobile engines.

* * *

D. M. Boyd, instrument engineer for Universal Oil Products, Chicago, has been granted the degree of Chemical Engineer from the University of Colorado for his development work on the graphic instrument panel. He is chairman of the production processes committee of the Instrument Society of America and a member in both the American Institute of Chemical Engineers and the American Chemical Society.

* * *

John W. Payne, former supervisor of Socony-Vacuum Oil Co.'s process development division, has been made technical director of this division at the research and development laboratories in Paulsboro, N. J. Mr. Payne received his B.S. degree from Yale University in 1930 and has been associated with Socony-Vacuum since 1931.

* * *

E. W. Dean, former director of the standard inspection laboratory of Standard Oil Development Co., has been transferred to the New York staff as consulting chemist.

* * *

Harold W. Fisher, former deputy coordinator of Jersey Standard Oil Co.'s refinery operations, has been named head of the refinery coordination department. Mr. Fischer succeeds **William J. Haley** who has been made president of Esso Export Corp.

OBITUARIES

Dr. O. A. Beeck, associate director of research for Shell Development Co., Emeryville, Calif., died suddenly July 5, after a heart attack. He was born in Germany and received his education both in Europe and at the California Institute of Technology, where he was post-doctoral research fellow from 1930-33. He joined Shell Development as a research physicist in 1933, became head of the physics department in 1936 and an associate director in 1942.

* * *

Ernest F. Engelke, 66, senior research chemist for Lion Oil Co., Eldorado, Ark., died March 29. Born in New York and educated in U. S. and Switzerland, he began his career in the petroleum industry with the Nobel brothers at a refinery in Baku, Russia. From 1910-15 he was superintendent of Royal Dutch Shell Co.'s refinery operations in Java and Borneo, and from 1916-18 served as a consultant for Prudential Oil Co., Baltimore. While with Prudential he developed the British government's wartime oil transportation system. He was superintendent of Elaquila refinery, Tampico, Mexico, from 1918-22 and then until 1928 operated his own refinery in Budapest, Hungary. Returning to the U. S., he became research chemist for Cities Service Oil Co., later for Sinclair Oil Refining Co., and joined Lion Oil in 1943.

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EDITORIAL VIEWPOINTS...

Opinions and Comments on Current Topics

Clarify Reservists' Status!

REFINERS who are now surveying the technical manpower situation in their plants, engineering staffs and research departments, in the light of the demands for at least selected personnel that may soon come from the Armed Services, face very different problems than at the start of World War II. Then their men were taken almost entirely through the draft and pleas for exemption in the case of essential workers could be made through the Draft Boards.

Today, a large proportion of the technical men in the refining companies are in the reserves of the Army, Navy or Air Force, as an aftermath of their military experience. The manpower survey made by a National Petroleum Council committee for the National Security Resources Board showed that, for some companies as high as 30% of their technical personnel were in the reserves. One refiner heavily staffed with young engineers said that 75% of his key technologists are reservists. The same situation exists with the chemical manufacturing, steel, automotive and other industries, except that, save for chemical manufacturing, the proportion of reservists probably is not as high as in petroleum refining.

As matters stand today, reservists are subject to call without exemption except on the basis of family hardship. While both the NSRB and the Defense Department are aware of the problem of exempting reservists who are essential to the operation and maintenance of refineries and who are key men in research work, nothing has yet been worked out as to how this will be done.

However, refinery managers, in their manpower surveys, should list the data that will let them accurately present individual cases when the announcement comes from Washington on exemptions on essential work grounds. This data is particularly important in the case of reservists, for information on this group is not on file in Washington in many cases, or is not up-to-date as to the work the man is doing at present in the plant or laboratory. Data collected should include the man's experience, time required to train someone to take his place, and degree of essentiality in his present job. The refinery managers should make such surveys at once, in order that they may have concrete, accurate data in specific cases to talk from when the time comes.

Controlling Air Pollution

THE wide public interest in the abatement of contamination of streams and lakes by industrial waste and by sewage has brought about federal, state and other legislation on the subject the past few years. However, in this same period many measures have also been introduced to forbid or regulate air pollution by smoke, gas and vapors, although they have not received the same degree of publicity.

During the spring of 1949, a report to the Industrial Hygiene Foundation brings out, 33 measures relating to atmospheric pollution were introduced in 12 state legislatures. Three states, Rhode Island, Massachusetts and California, now have statutes prescribing specific limits on allowable emissions of air contaminants. There is no federal statute on the subject of air pollution but the President did proclaim a "National Air Pollution Abatement Week", last October, to publicize the necessity for abating air contamination.

That the problem of identifying, determining and controlling air pollution is exceedingly complex has not deterred local politicians from making an issue of it, as many refiners have already learned. The fact that the programs on stream pollution are further advanced than those on air contamination should not detract from the refiner's attention to this phase of the subject.

Means for Motor Fuel Conservation

THE change in motor gasoline specifications, to raise the maximum allowable vapor pressure limit from 13.5 to 15 pounds in winter over a considerable part of the country, as recently provided by ASTM Committee D-2, may have come at a very opportune time. The conservation in the production of refinery gasoline which could be effected by making greater use of butanes in blending, particularly natural gas butanes, might prove of considerable benefits to refiners if they are called on for an extended war effort. Motor fuel octane values would be improved also, since the butanes are essentially a 100-octane product.

As competent an authority as R. C. Alden, Director of Research, Phillips Petroleum Co., has stated that, in 1946, the improvement in automotive fuel systems to provide satisfactory operations with fuels of one pound more in vapor pressure would have permitted inclusion of 9,700,000 bbls. of butane in the motor fuel marketed that year. At the gasoline yield ratio in that year, refiners processed 21,700,000 bbls. of crude to turn out this volume of motor fuel, and it represented about 4.5 days of refinery operations.

Any effort to say how much our volume of motor gasoline will be extended through the present raising of the volatility limits or to say to what extent refiners will put out fuels meeting the new specifications, would be pure speculation. In general, the change could provide for using up to about 2% more butane in motor gasoline in the territory and for the period defined. At least until it is known what effect the use of the more volatile fuels will have in some of the old vehicles in use which may be subject to vapor lock, refiners will continue to supply some gasolines to the former specifications. Some say they will meet the new vapor limit only in their premium gasoline.

However, the change in the specification is definitely a step in the right direction. While there are other uses for natural gas butanes, their inclusion in motor fuel offers by far the largest outlet. Our conservation policies in gas production insure that increasingly large volumes of butanes will be produced. Under any extended war effort it will behoove both the automobile and the oil companies to provide for as wide utilization of butanes in gasoline as is practicable in motor vehicle operation.

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USES OF ANHYDROUS HYDROFLUORIC ACID

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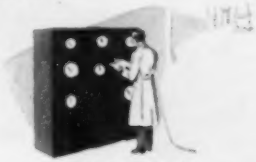

Production of fluorine

Hydrofluoric Acid (AQUEOUS)

USES OF AQUEOUS HYDROFLUORIC ACID

Polishing, etching, frosting glass

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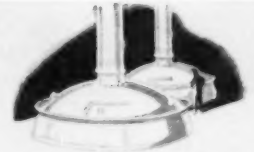
Electroplating

—2 VERSATILE CHEMICALS FOR AMERICAN INDUSTRY

Cleaning stone, brick



In breweries to control fermentation

For dissolving ores; ore flotation

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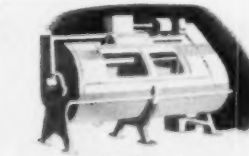

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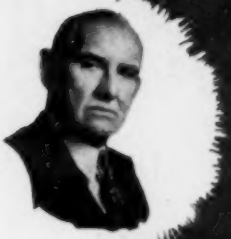

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